PowerConnect W-Series Campus Wireless Networks

Validated Reference Design Version 8

Contents

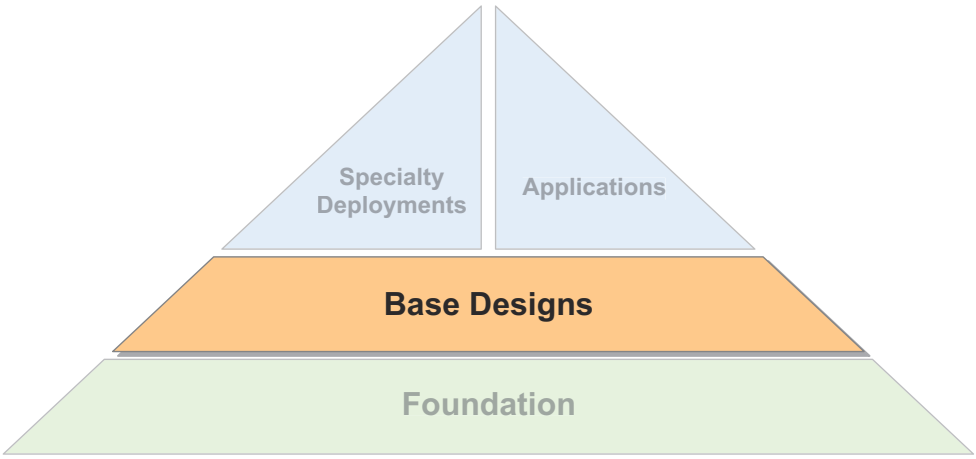
Chapter 1: Dell Reference Architectures

The Dell Validated Reference Design (VRD) series is a collection of technology deployment guides that include descriptions of Dell technology, recommendations for product selections, network design decisions, configuration procedures, and best practices for deployment. Together these guides comprise a reference model for understanding Dell technology and designs for common customer deployment scenarios. Each Dell VRD network design has been constructed in a lab environment and thoroughly tested by Dell engineers. Our customers use these proven designs to rapidly deploy Dell solutions in production with the assurance that they will perform and scale as expected.

The VRD series focuses on particular aspects of Dell technologies and deployment models. Together the guides provide a structured framework to understand and deploy Dell wireless LANs (WLANs). The VRD series has four types of guides:

- Foundation: These guides explain the core technologies of a Dell WLAN. The guides also describe different aspects of planning, operation, and troubleshooting deployments.
- Base Design: These guides describe the most common deployment models, recommendations, and configurations.
- Applications: These guides are built on the base designs. These guides deliver specific information that is relevant to deploying particular applications such as voice, video, or outdoor campus extension.
- Specialty Deployments: These guides involve deployments in conditions that differ significantly from the common base design deployment models, such as high-density WLAN deployments.

Figure 1 *VRD Core Technologies*



This guide covers the deployment of Dell WLAN in a typical campus network, and it is considered part of the base designs guides within the VRD core technologies series. This guide covers the design recommendations for a campus deployment and it explains the various configurations needed to implement the Dell secure, high-performance, multimedia grade WLAN solution in large campuses. This guide describes these specific topics:

- recommended campus network design
- configuration of redundancy in campus deployments
- configuration of AP groups for client access and air monitors
- configuration of spectrum monitors (SMs)
- configuration of Layer 3 mobility
- configuration of control plane security (CPsec)

Table 1 lists the current software versions for this guide.

Table 1 *Software Versions*

Product	Version
ArubaOS (mobility controllers)	6.1
Instant	2.0
AirWave	7.4
ClearPass GuestConnect	3.7

Reference Material

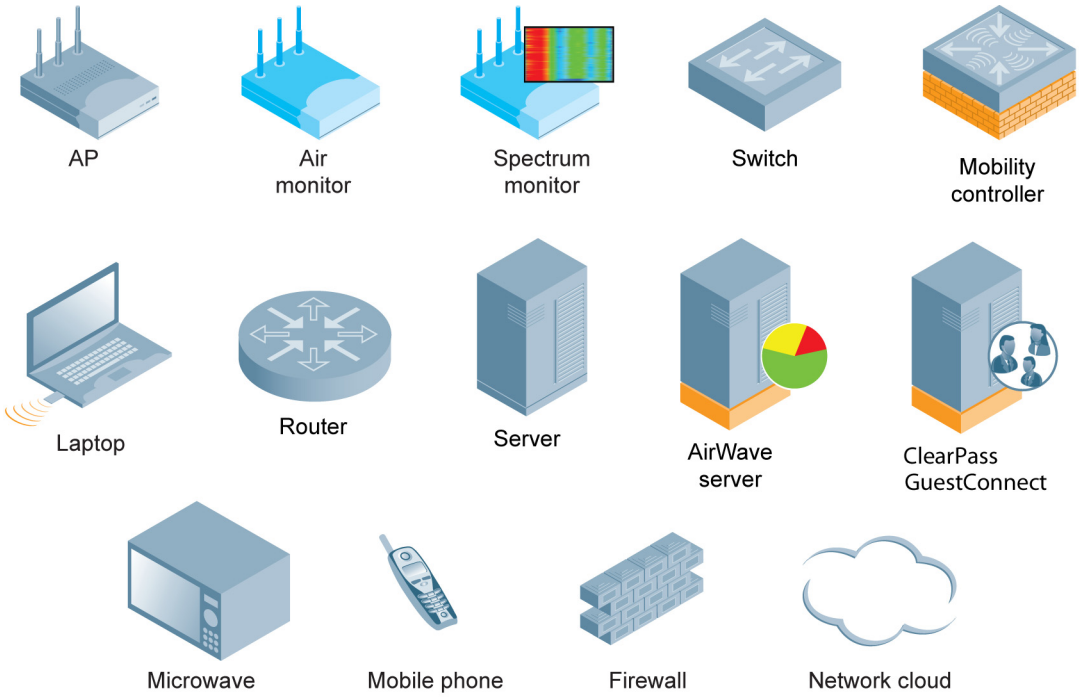
This guide is a base designs guide, and therefore it will not cover the fundamental wireless concepts. This guide helps a wireless engineer configure and deploy the Dell WLAN in a campus environment. Readers should have a good understanding of wireless concepts and the Dell technology that are explained in the foundation-level guides.

- Dell PowerConnect W-Series technical documentation is available for download from the Dell support site http://support.dell.com/manuals. These documents present detailed feature and functionality explanations outside the scope of the VRD series.
- Support for the Dell PowerConnect W-Series can be found at http://support.dell.com/wireless

Icons Used in this Guide

Figure 2 shows the icons that are used in this guide to represent various components of the system.

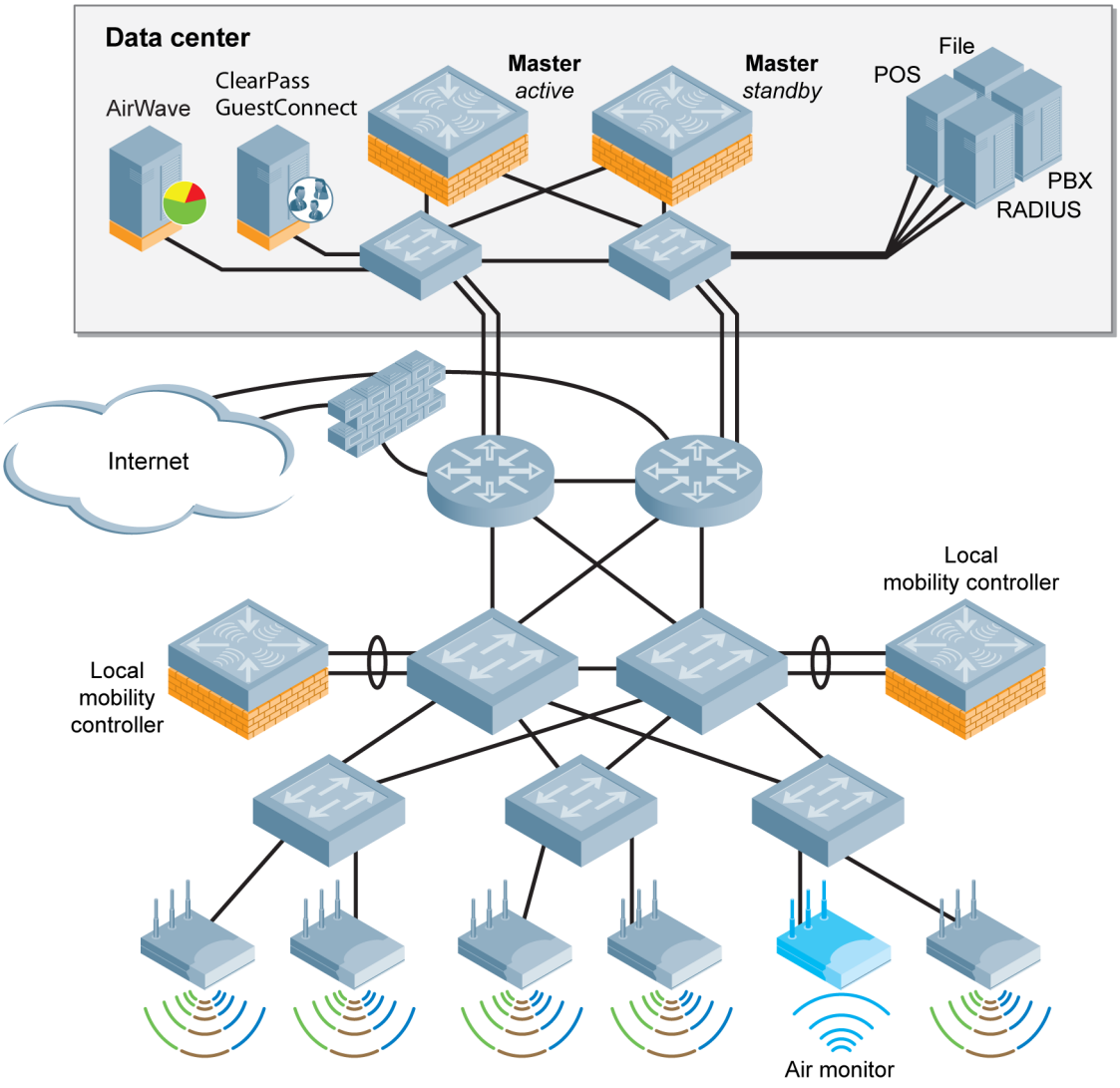
Figure 2 *VRD Icon Set*



Chapter 2: Campus Deployments

Campus deployments are networks that require more than a single active controller to cover a contiguous space. Examples of campus deployments are corporate campuses, large hospitals, and higher-education campuses. In these deployments, the WLAN is typically the primary access method for the network, and it is typically used by multiple classes of users and devices. Figure 3 depicts a cluster-based architecture that is typical of large enterprise deployments.

Figure 3 *Typical campus deployment with redundancy*



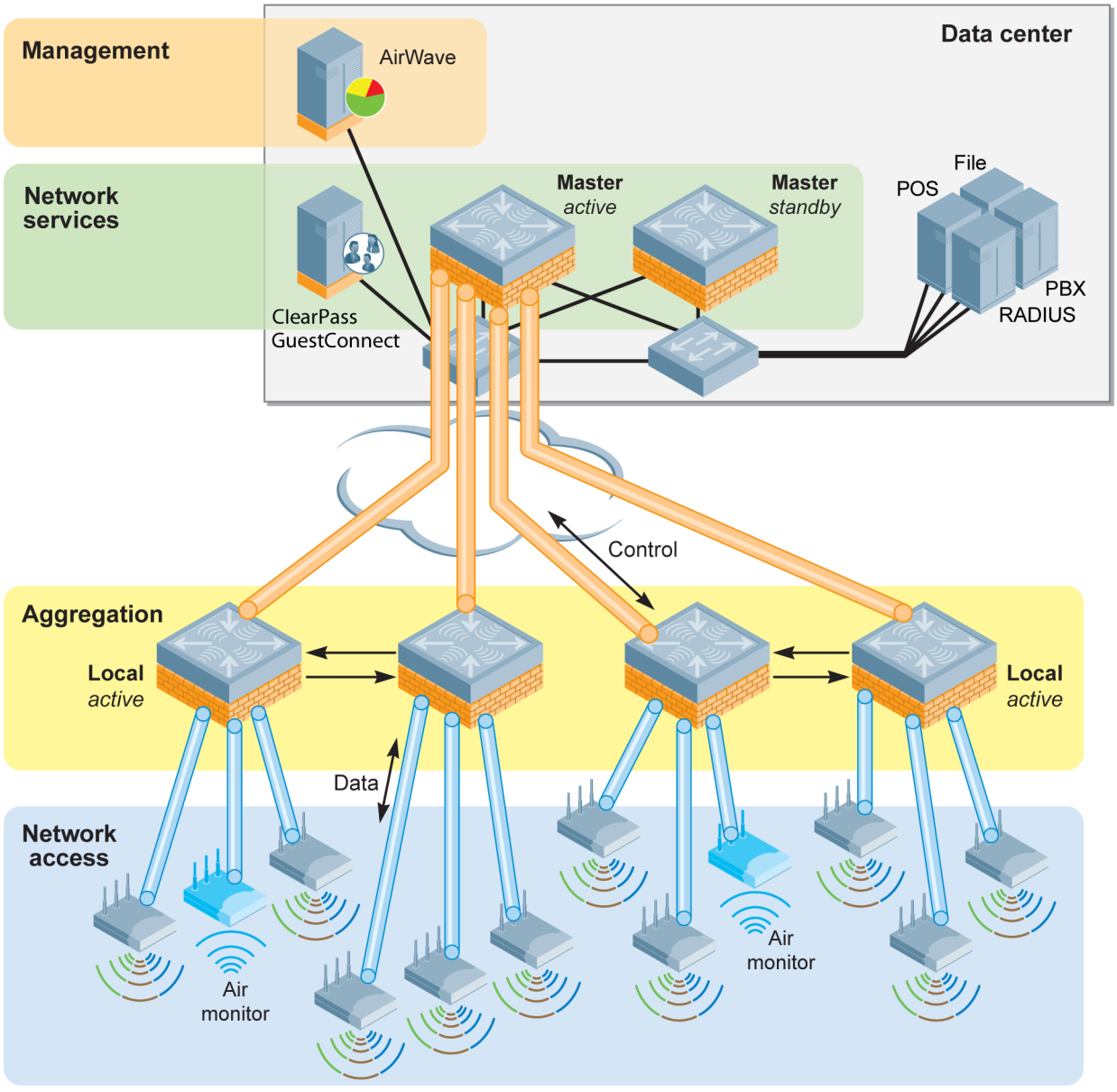
Dell Campus WLAN Logical Architecture

Dell WLAN has a logical four-tier operating model that consists of these four layers:

- **Management:** The management layer consists of AirWave®. AirWave provides a single point of management for the WLAN, including reporting, heat maps, centralized configuration, and troubleshooting.

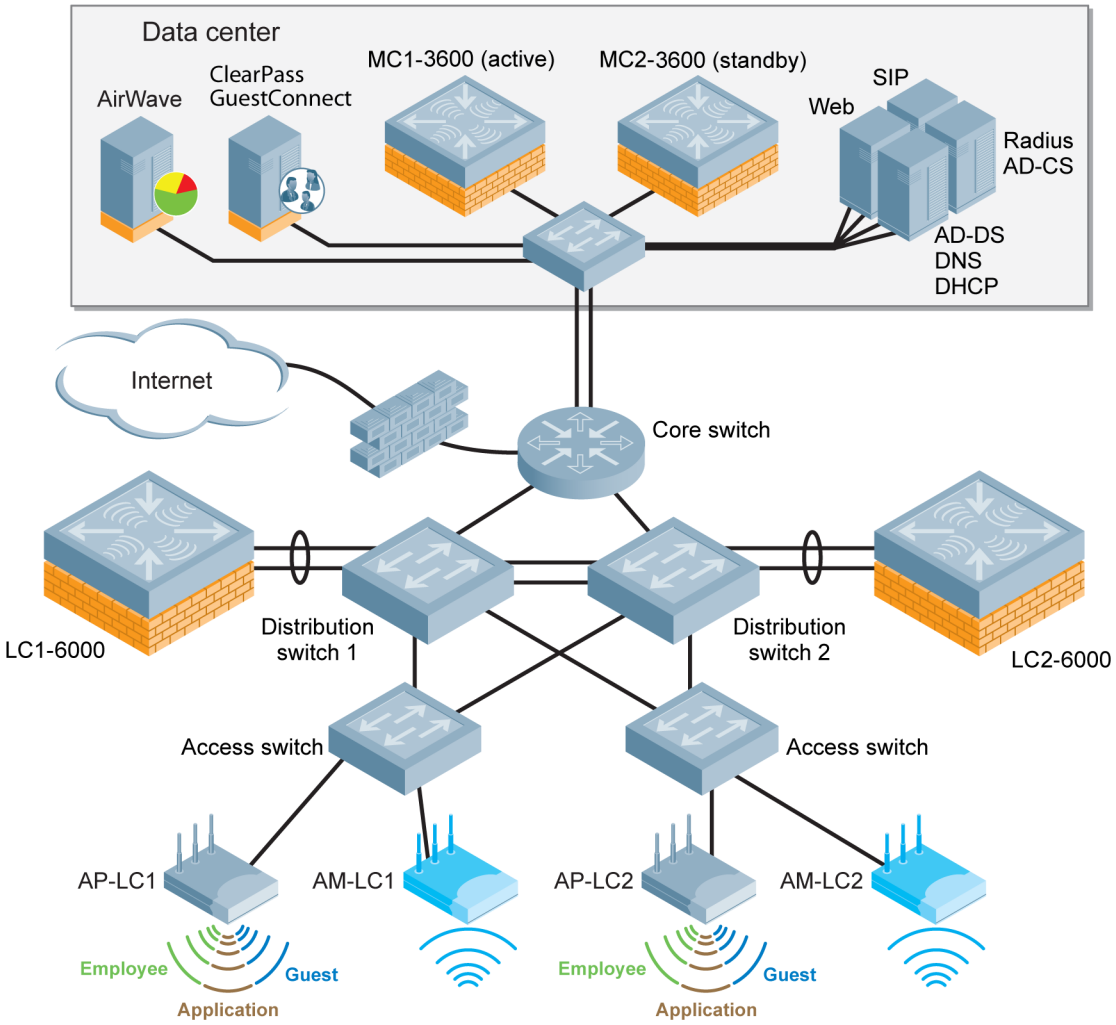
- **Network services:** The network services layer consists of master mobility controllers and ClearPass GuestConnect. ClearPass GuestConnect provides secure and flexible visitor management services. The master controllers provide a control plane for the Dell WLAN that spans the physical geography of the wired network. The control plane does not directly deal with user traffic or APs. Instead the control plane provides services such as whitelist coordination, valid AP lists, CPsec certificates, RFProtect™ coordination, and RADIUS or AAA proxy.
- **Aggregation:** The aggregation layer is the interconnect point where the AP, air monitor (AM), and spectrum monitor (SM) traffic aggregates. This layer provides a logical point for enforcement of roles and policies on centralized traffic that enters or exits the enterprise LAN.
- **Network access:** The network access layer is comprised of APs, AMs, and SMs that work together with the aggregation layer controllers to overlay the Dell WLAN.

Figure 4 *Dell Campus WLAN Logical Architecture*



An example network is used to explain the deployment of a Dell user-centric network in the large complex campus network presented in, “Chapter 2: Campus Deployments” on page 3. All networks parameters, screenshots, and command line interface (CLI) examples shown in this VRD are from the VRD example network. For details on the network parameters, design and setup of the entire VRD example network, see the *PowerConnect W-Series Basic Topology VRD*.

Figure 5 *VRD example network*

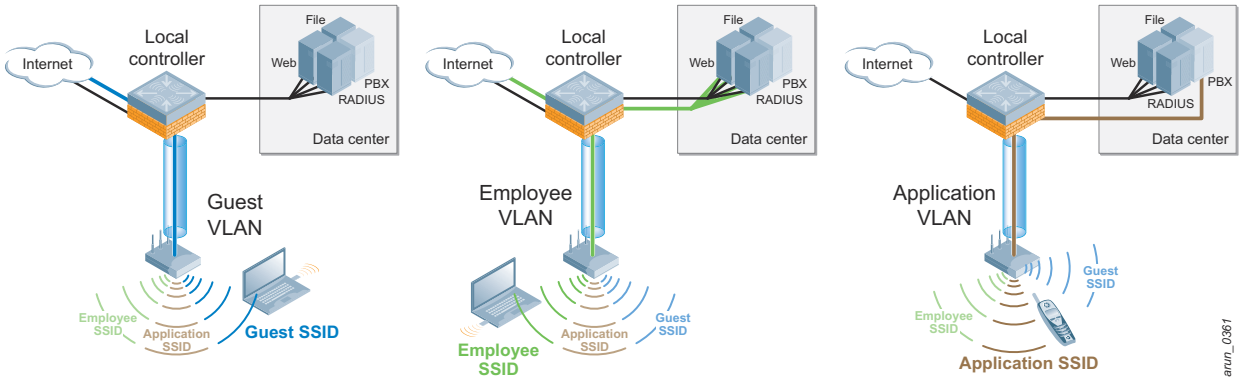


This VRD describes how to configure these WLANs:

- employee WLAN
- application WLAN (for 802.1X-incapable VoIP devices)
- guest WLAN

Employee WLAN emulates a converged voice and data network typical of most campus deployments. Employee users and all corporate devices that are capable of 802.1X authentication use the employee SSID. In the example network, an employee user has full access to all the network resources and the internet. Guests use the guest SSID. Guest users are permitted to access the Internet using only specific protocols such as HTTP and HTTPS. Only corporate devices that are not capable of 802.1X authentication associate to the application SSID. These legacy devices that are not capable of 802.1X are allowed to access only the necessary application servers. For example, a VoIP phone running SIP can access only the SIP server to make calls.

Figure 6 *Role-based access*



The deployment scenario in this VRD portrays the needs of most campus deployments. However, the requirements of each organization are different. Your network may differ from the VRD example network in these ways:

- VLAN and IP parameters
- user density and VLAN pools
- availability, redundancy, and performance requirements
- type of devices on the network
- applications running on the network
- user role requirements
- authentication and encryption requirements
- SSID requirements
- quality of service (QoS) requirements
- intrusion detection and intrusion prevention requirements
- mobility requirements
- network management requirements

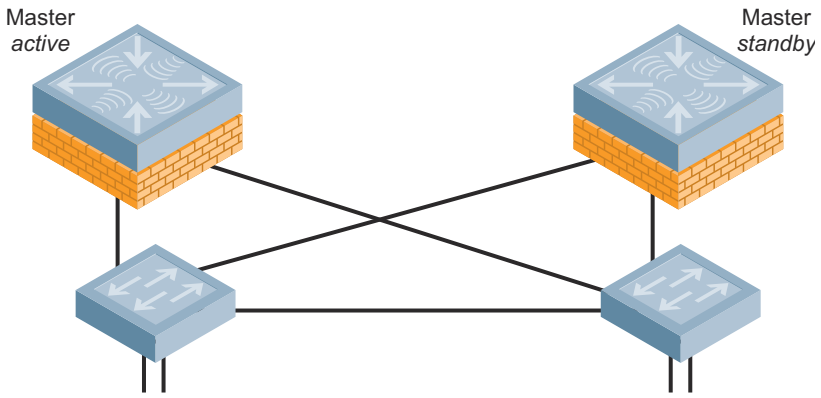
The network parameters and Dell configurations shown in this VRD should be adjusted to meet your needs.

Recommendations for Key Components

Some key components of this reference model include:

- **Master controllers:** The PowerConnect W-3600 controller is recommended for master controllers that do not terminate any APs or AMs. The master controllers should be deployed in pairs for redundancy. The master controller should be given adequate bandwidth connections to the network, preferably a minimum of a Gigabit Ethernet LAN connection. A general best practice is to configure each W-3600 controller in a full mesh with redundant links to separate data center distribution switches. The W-3600 does not have redundant power supplies, so it is recommended that you connect each appliance to discrete power sources in the data center.

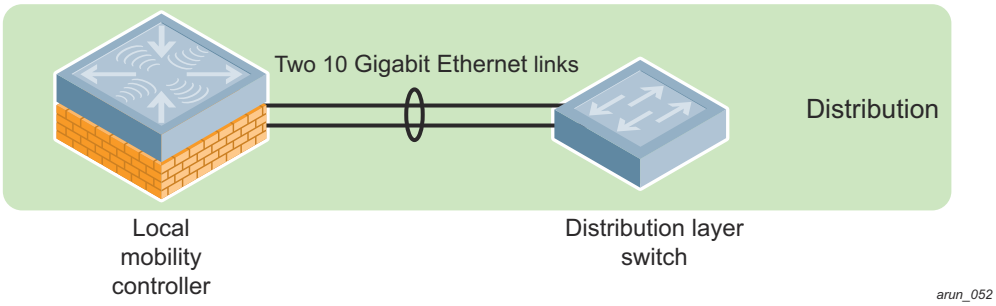
Figure 7 *Master controllers deployed in full mesh topology*



- **Local controllers:** Use the W-6000M3 Controller Module for local controllers. In a pair of W-6000M3 controller modules configured for local controller redundancy, each controller should have its own W-6000 chassis. Two W-6000 chassis can accommodate four pairs of redundant local controllers. Connect each module to its own distribution layer switch with two 10 Gigabit Ethernet connections with link aggregation. For configuration of link aggregation, see, "Appendix A: Link Aggregation" on page 121. The W-6000 chassis should contain redundant power supplies connected to discrete power sources. See the PowerConnect W-Series mobility controller product line to choose the most appropriate mobility controller for your deployment.

NOTE: Controllers that are redundant should not be placed in the same chassis, because a chassis failure will cause the redundancy architecture to fail.

Figure 8 *Link Aggregation*



- **Access points:** Dell offers a wide range of 802.11n APs. The spectrum capability and the capacity of the APs vary. See the entire Dell PowerConnect W-AP product line at http://www.dell.com/wireless to choose the most appropriate AP for your deployment.
- **Air monitors:** Deploy AMs at a ratio of approximately one AM for every four APs deployed, and around the building perimeter for increased security and location accuracy. AMs perform many of the intrusion detection system (IDS) duties for the network, including rogue AP containment. AMs help to form accurate heat maps that display graphical RF data. Dell considers dedicated AMs to be a best practice for security because they provide full-time surveillance of the air. Use the W-AP105 as AMs, because these are dual-radio APs with full spectrum analysis support. Details on the spectrum capabilities of all the Dell PowerConnect W-APs can be found at Dell http://www.dell.com/wireless.

Chapter 3: Master/Local Operation

Large campus deployments normally involve more than two controllers. When you have more than a single pair of controllers, change control and network consistency can become an issue. To solve this management scalability issue, Dell PowerConnect W-Series Mobility Controllers can be deployed in clusters that consist of a master and one or more local controllers. This design is the recommended model when two or more controllers exist in the same network. This design is depicted in this VRD.

In a Dell network that uses a master/local design, configuration is performed only on the master and it is pushed down to the locals.

NOTE: In a large campus WLAN that has separate network services and aggregation layers, APs and AMs should never terminate on the master controller. APs and AMs should terminate only on the local controller. With this configuration, if the master becomes unreachable or unavailable and no standby master has been configured, the network continues to operate as expected, except for certain operations. You cannot perform configuration, RF visualization, or location services until connection to the master controller is restored. The master controller is needed to perform configuration and reporting, but it is not a single point of failure in the network.

Local controllers reside at the aggregation layer of the Dell overlay architecture. They handle AP termination, user authentication, and policy enforcement. When you configure any local controller, you must know the IP address of the master and the pre-shared key (PSK) that was used to encrypt communication between the controllers. The control channel between all Dell controllers is protected by an IP Security (IPsec) connection. For more details on the functions and responsibilities of master and local mobility controllers in Dell architecture, see the *PowerConnect W-Series Mobility Controllers Validated Reference Design*.

NOTE: The controllers have a preconfigured key at first boot. Change this key after the first boot so that the operation of the master/local cluster is secure.

Controller Licenses

The ArubaOS™ base operating system contains many features and extensive functionality for the enterprise WLAN network. Dell uses a licensing mechanism to enable the additional features and to enable AP capacity on controllers. The controller licensing depends on the user density and the features needed to operate and secure your network. For more details about Dell licenses, see the *PowerConnect W-Series Mobility Controllers Validated Reference Design*.

Licensing Master Mobility Controllers

The master mobility controller must manage the functionality for all other platforms, so the master must have the same license types as the local mobility controllers. Licensing unlocks the configuration capabilities on the system. However, the master does not terminate APs or devices, so the master can be licensed at a much lower level than the local mobility controller.

NOTE: Only the functionality that is being enabled needs to be licensed. For example, xSec is deployed primarily only in Federal Government and military installations, and it is not required unless it will be in use at the organization.

Table 2 lists the licenses that are used by the active and the standby master controllers in the example network.

Table 2 *Master Controller Licensing in the Example Network*

License	Capacity
AP Capacity	0
PEF-NG	1
RFProtect	1

Licensing Local Mobility Controllers

Local controllers must be licensed according to the number of devices that consume licenses. Mobility controllers should be licensed at the maximum expected capacity for that mobility controller. For instance, in a failover scenario, the backup controller must be licensed to accept all the APs that it could potentially host if a failure occurs, even if that is not the normal operating level.

In the example network, the two local mobility controllers are designed for active-active redundancy. Each terminates a 40% load of APs and acts as the backup for the APs on the other controller. Each controller is licensed to 80% of maximum capacity. If one mobility controller fails, the other controller can add the additional APs from the failed controller.

Table 3 lists the licenses used by the local controllers in the example network.

Table 3 *Local Controller Licensing in the Example Network*

License	Capacity
AP Capacity	416
PEF-NG	416
RFProtect	416

Certificates

The Dell controller comes with a default server certificate. This certificate demonstrates the secure login process of the controller for captive portal, secure shell (SSH), and WebUI management access. This certificate is not recommended for use in a production network. Dell strongly recommends that you replace this certificate with a unique certificate that is issued to the organization or its domain by a trusted certificate authority (CA).

To receive a custom certificate from a trusted CA, generate a Certificate Signing Request (CSR) on the controller and submit it to the CA. After you receive the digitally signed certificate from the CA, import it to the controller. For more details about generating the CSR and importing certificates, see “Managing Certificates” in the *ArubaOS User Guide* available at support.dell.com/manuals.

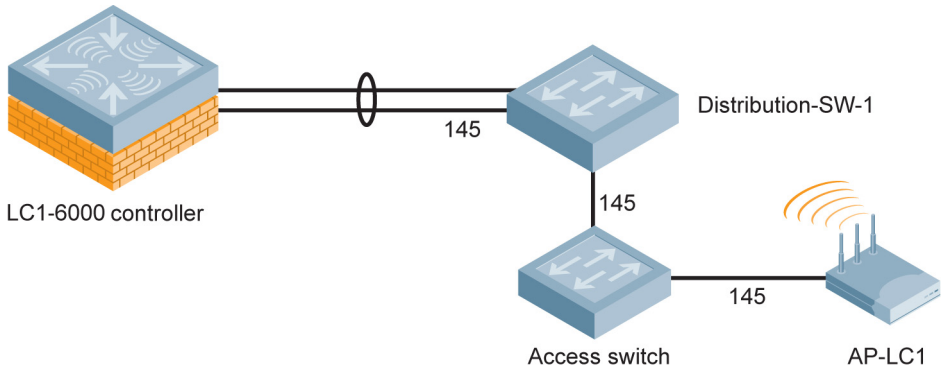
On a Dell controller at the aggregation layer, VLANs are used in two logically different places:

- the access side of the controller where the APs terminate their GRE tunnels
- the user access side

VLANs are used on the access side of the controller where the APs terminate their GRE tunnels. These VLANs carry traffic back and forth between APs and the controllers. Dell strongly recommends that edge access VLANs should not be dedicated to APs. The only exception where the APs may have to be deployed on dedicated VLANs is in environments where 802.1X is a requirement on the wired edge. The APs should use the existing edge VLANs as long as they have the ability to reach the mobility controller. Deploying the APs and AMs in the existing VLANs allows for the full use of the Dell rogue detection capabilities. In pre 6.1 ArubaOS, the AMs had to be connected to a trunk port that contains all VLANs that appear on any wired access port within range of the AM. This connection was required for the AM to do wireless-to-wired correlation when tracking rogue APs. In ArubaOS 6.1, the network administrators have the option of trunking all the VLANs available in the access layer to the controller instead of trunking them to APs or AMs. Remember that all the access VLANs should be trunked to every controller in the network that terminates APs and AMs. When all the access VLANs are trunked to the controller, the controller assists the APs and AMs in wireless-to-wired correlation during rogue detection. Depending on your network design, you must choose between trunking the VLANs to the controller or to the APs and AMs.

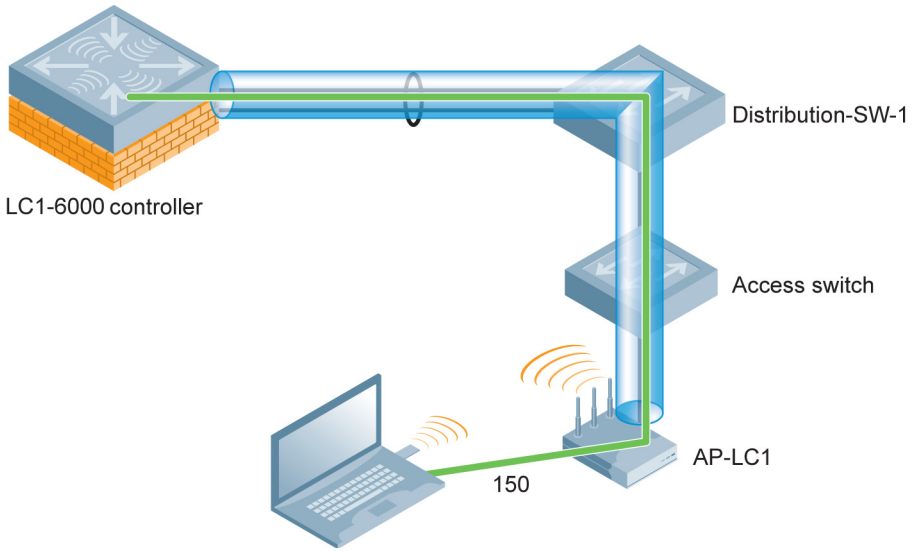
NOTE: Wired containment requires that the hearing AP or AM is on the same subnet as the contained device. If your access network has many VLANs and if you want wired containment on all those VLANs, deploy the AMs on trunk ports.

Figure 9 *AP plugged into a local switch, accessing the mobility controller*



VLANs are also used on the user access side. On the user access side, user VLANs exist and traffic flows to and from the users. During authentication, a process that is called “role derivation” assigns the proper VLAN to each user and forwards traffic to the wired network if allowed. For campus networks, Dell recommends that you do not deploy the controllers as the default gateway for user VLANs. The existing Layer 3 switches should remain the default gateways for all user VLANs. The Dell controllers should be deployed as a Layer 2 switched solution that extends from the distribution layer. The controllers should be the default gateway and DHCP server only for the guest VLAN. For more details about VLAN design, see the *PowerConnect W-Series Mobility Controllers Validated Reference Design*.

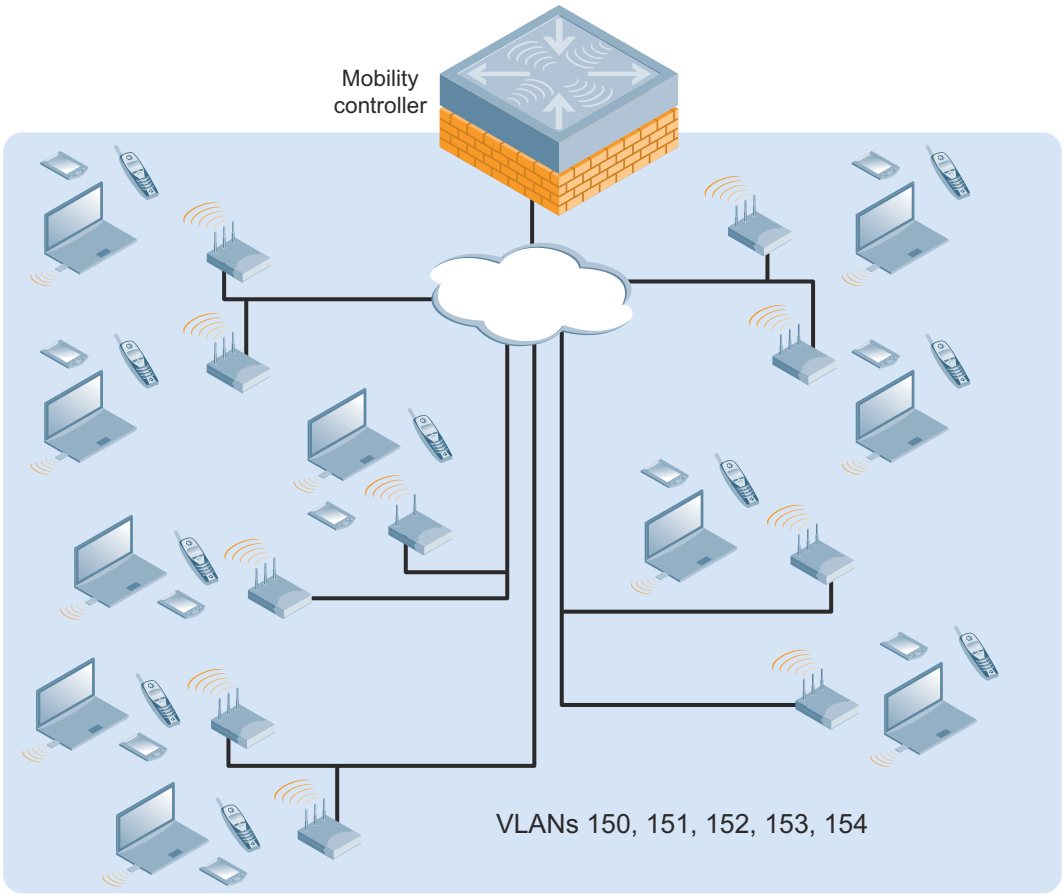
Figure 10 *User VLAN, logical connection*



VLAN Pooling

The Dell VLAN pooling feature allows a set of VLANs to be assigned to a designated group of users. VLAN pooling is tied to the virtual access point (VAP). Each VAP on a physical AP can have different VLANs or VLAN pools. Dell recommends using VLAN pools any time two or more user VLANs are needed to support the user load from a single set of APs going to a single mobility controller. For more details about VLAN pooling, see the *PowerConnect W-Series Mobility Controllers Validated Reference Design*.

Figure 11 *VLAN pools distribute users across VLANs*



To determine which pool to put the user into, the user MAC address is run through a hash algorithm. The output of this algorithm places the user into one of the VLANs in the pool and ensures that the user is always placed into the same pool during a roaming event. As the user associates with the next AP, the address is hashed. The user is again placed into the same VLAN on the new AP, because the hash algorithm generates the same output as before. The user can continue to use their existing IP address with no break in their user sessions.

NOTE: The hashing algorithm does not place users into the available pool of VLANs in a round-robin method. Ten clients that join a WLAN are not load balanced equally among the VLANs. Instead, the distribution is based on the output of the hash. One VLAN might have more users than the others. For example, consider 150 clients that join a WLAN with just two VLANs in the pool and with 80 addresses per VLAN available for clients. Based on the output of the hashing algorithm, 80 clients are placed in one VLAN and 70 in the other. When the 151st client joins, the output of the hash might place the client in the VLAN whose scope of 80 addresses has already exhausted. The result is that the client cannot obtain an IP. To avoid such a rare situation, the network administrator should design pools with sufficient number of user VLANs and DHCP scopes to accommodate the intended user density.

A single VLAN or a VLAN pool can be named by the administrator. The VLAN names are global, but the VLAN IDs associated with those names are local to the controller. The VLAN names are configured globally in the master

controller and are synchronized to the local controllers. The VLAN IDs that are associated to a particular VLAN name are defined in the local controllers and can vary across the controllers.

NOTE: During VLAN pooling, the controller places the user into a particular VLAN based on the hash calculated using the media access control (MAC) address of the client. Hence, the VLAN obtained as a result of the hashing algorithm cannot be predicted beforehand. In networks that use VLAN pooling, the clients with static IP addressing will not work because the statically assigned VLAN and the VLAN obtained by the controller after running the hash can be different. Dell recommends that VLAN pooling and static IP addressing should never be used simultaneously within a single SSID.

The example network uses 10 VLANs (VLAN 150-159) split into these two pools:

- pool-7 is used by the employee and application VAPs in the AP group that uses the virtual IP (VIP) of Virtual Router Redundancy Protocol (VRRP) instance 7 as the local management switch (LMS) IP.
- pool-8 is used by the employee and application VAPs in the AP group that uses the VIP of VRRP instance 8 as the LMS IP.

Table 4 lists the VLAN pools that are used in the example network.

Table 4 *VLAN Pools in the Example Network*

Pool Name	VLANs
pool-7	150-154
pool-8	155-159

CLI Configuration

MC1-3600

```
!
vlan-name pool-7 pool
vlan-name pool-8 pool
!
```

LC1-6000

```
!
vlan-name pool-7 pool
 vlan pool-7 150-154
vlan-name pool-8 pool
 vlan pool-8 155-159
!
```

LC2-6000

```
!
vlan-name pool-7 pool
 vlan pool-7 150-154
vlan-name pool-8 pool
 vlan pool-8 155-159
!
```

WebUI Screenshot

Figure 12 *VLAN pool on MC1-3600*

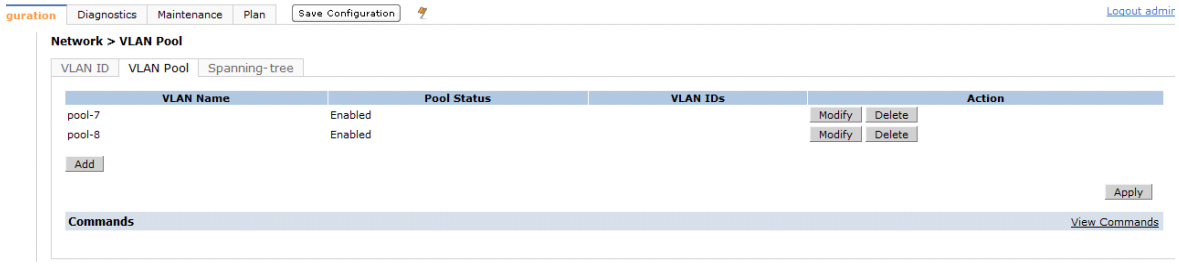


Figure 13 *VLAN pool on LC1-6000*

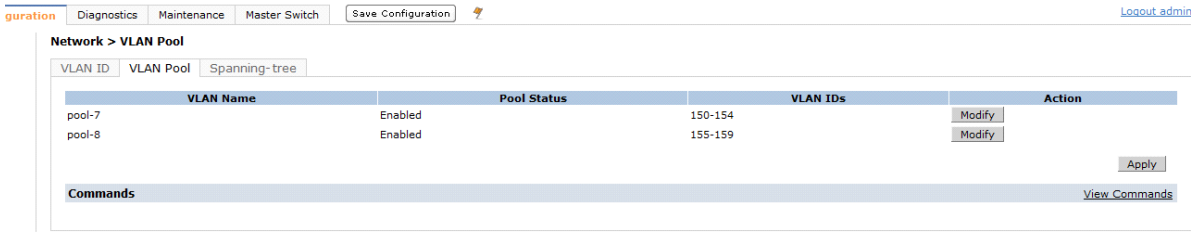
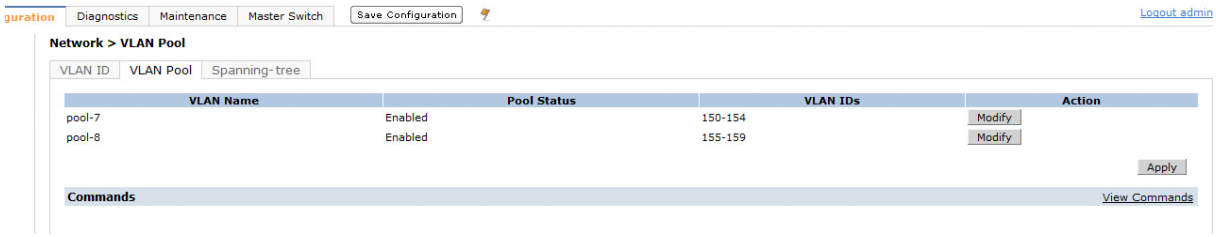


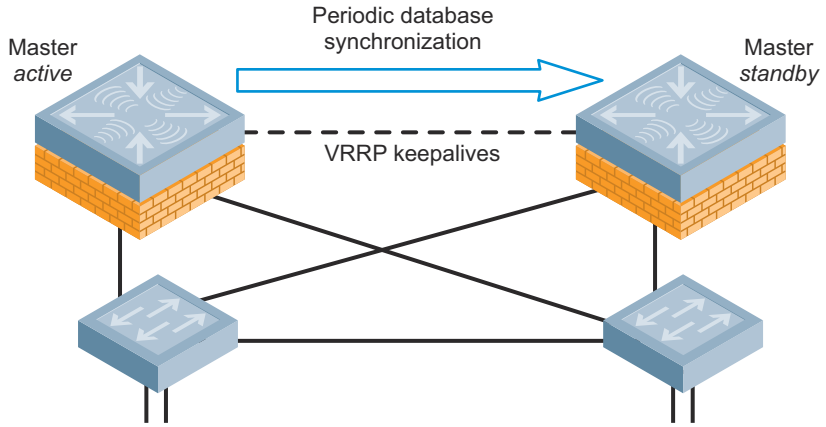
Figure 14 *VLAN pool on LC2-6000*



Dell PowerConnect W-Series offers several redundancy models for master controller redundancy and local control redundancy. The Dell PowerConnect W-Series redundancy solutions can be implemented using VRRP or backup LMS IP. Use VRRP, which operates at Layer 2, for redundancy whenever possible. For more details about the various redundancy models and when to use backup LMS IP, see *PowerConnect W-Series Mobility Controller Validated Reference Design.*

To achieve high availability of the master controller, use the master redundancy model. In this scenario, two controllers are used at the network services layer: one controller is configured as the active master and the other controller acts as standby master. This setup is known as "hot standby" redundancy. The two controllers run a VRRP instance between them and the database and RF planning diagram is synchronized periodically. The VIP address that is configured in the VRRP instance is used by local mobility controllers, wired APs, and wireless APs that attempt to discover a mobility controller. That VIP address is also used for network administration. The DNS query made by APs to find the master controller resolves to this VIP. The synchronization period is a configurable parameter with a recommended setting of 30 minutes between synchronizations.

Figure 15 *Hot-standby redundancy*



In this configuration, one controller is always the active master controller and the other is always the standby master controller. When the active controller fails, the standby controller becomes the active master. Disable preemption in this setup. When preemption is disabled, the original master controller does not automatically become the active master after it has recovered and instead acts as the backup master controller. The recommended network attachment method is to have each master controller configured in a full mesh with redundant links to separate data center distribution switches. The example network uses a VRRP instance named 130 for redundancy.

Table 5 and Table 6 summarize the VRRP instance used for master redundancy in the example network.

Table 5 *VRRP Instance Used for Master Redundancy*

VRRP ID	VRRP IP	Active Controller	Standby Controller	Tracking Master Up Time	Tracking Master Up Time Priority
130	10.169.130.8	MC1-3600 (Priority 110)	MC2-3600 (Priority 100)	30	20

Table 6 *Database Synchronization Parameters*

Enable Periodic Database Synchronization	Database Synchronization Period in Minutes	Include RF Plan Data
enabled	30	enabled

CLI Configuration

MC1-3600

```
!
master-redundancy
  master-vrrp 130
  peer-ip-address 10.169.130.7 ipsec **********
!
vrrp 130
 priority 110
 ip address 10.169.130.8
 description "Preferred-Master"
 vlan 130
 tracking master-up-time 30 add 20
 no shutdown
!
database synchronize period 30
database synchronize rf-plan-data
!
```

MC2-3600

```
!
master-redundancy
  master-vrrp 130
  peer-ip-address 10.169.130.6 ipsec **********
!
vrrp 130
 ip address 10.169.130.8
 description "Standby-Master"
 vlan 130
 tracking master-up-time 30 add 20
 no shutdown
!
database synchronize period 30
database synchronize rf-plan-data
!
```

WebUI Screenshot

Figure 16 *VRRP-130 on MC1-3600*

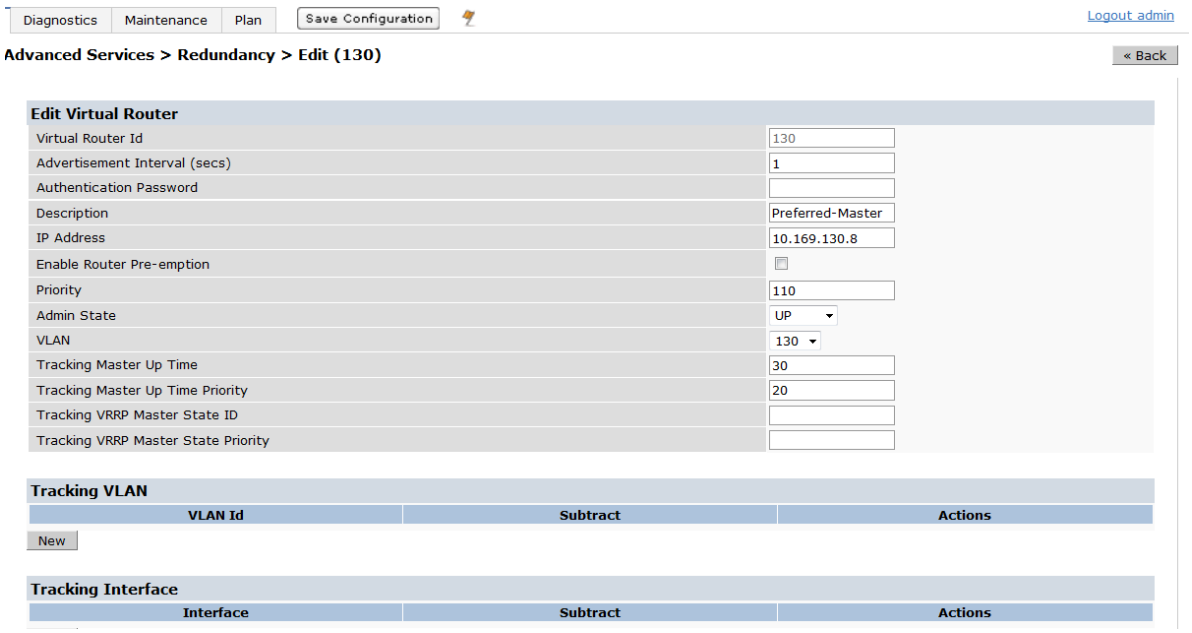


Figure 17 *VRRP table on MC1-3600*

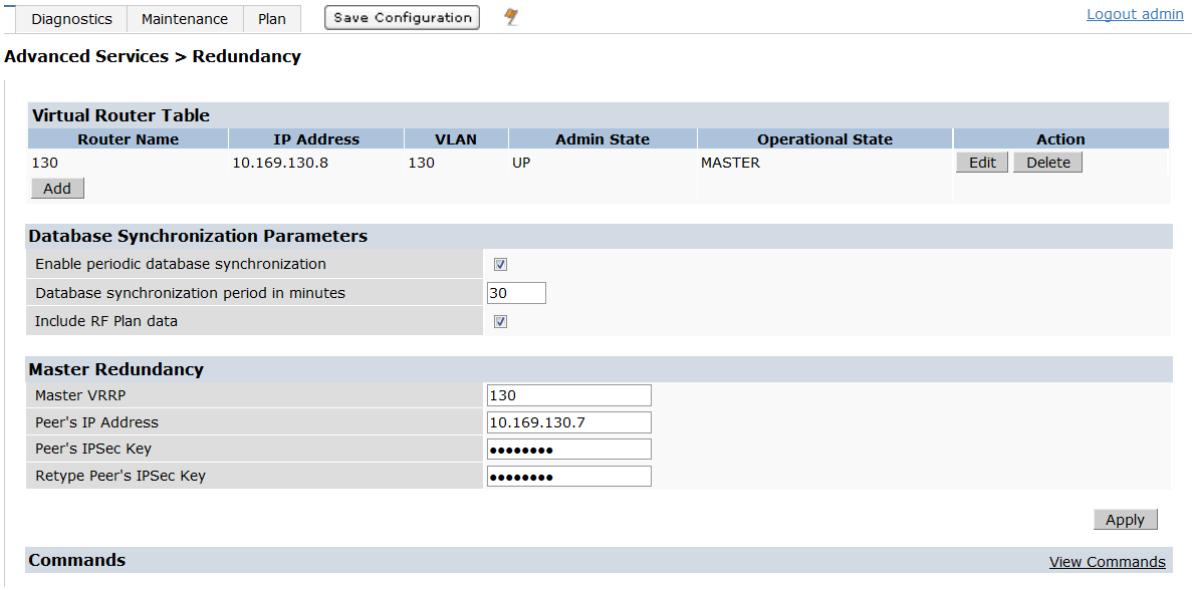


Figure 18 *VRRP-130 on MC2-3600*

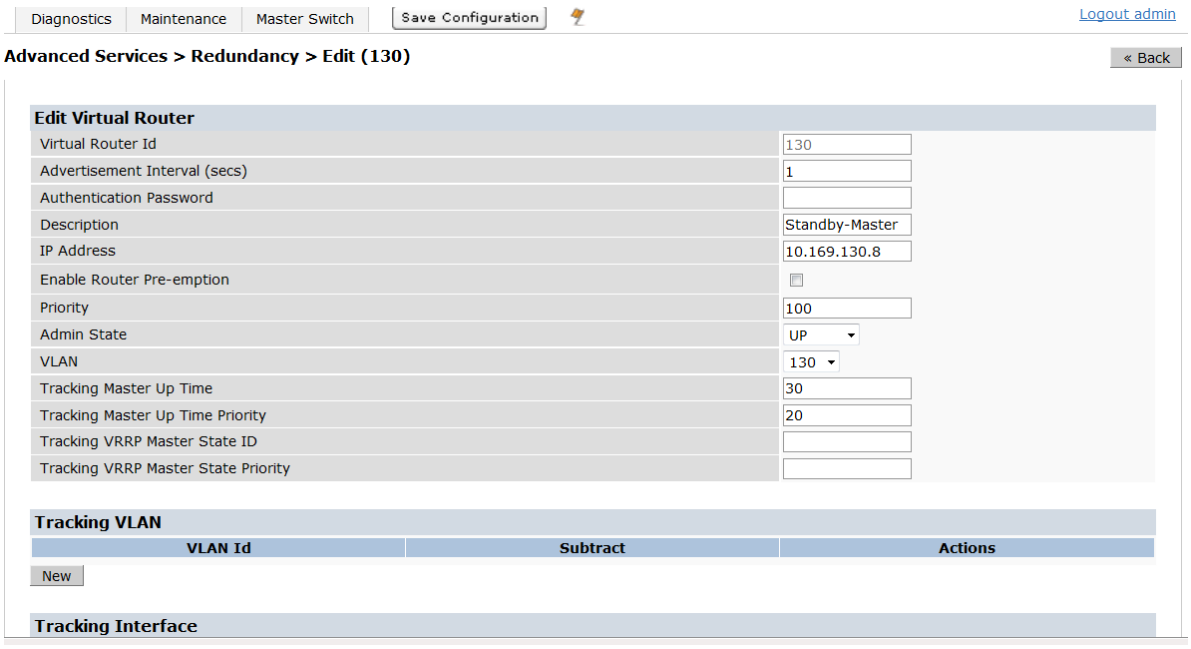
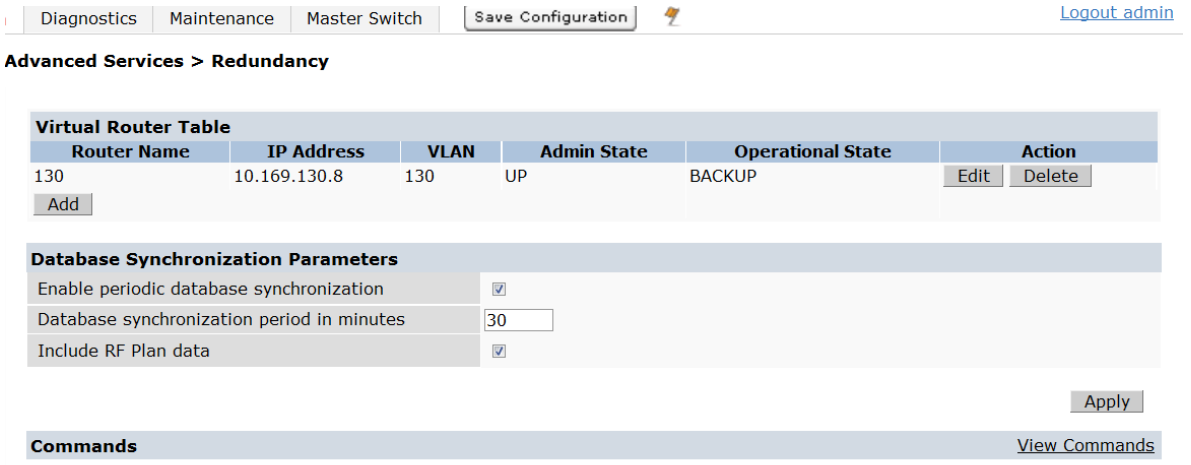


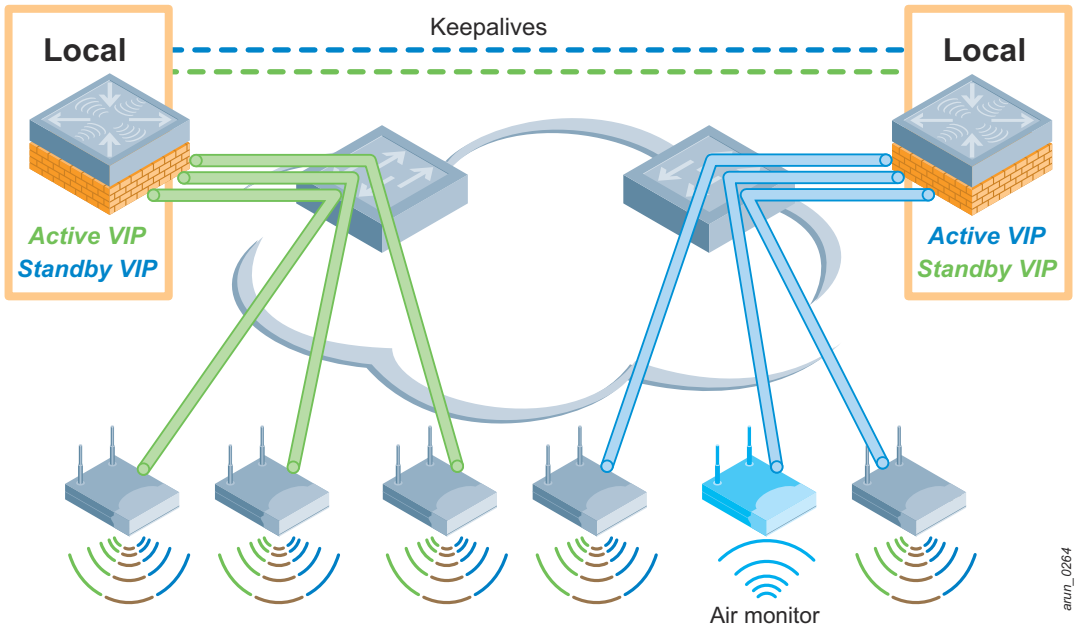
Figure 19 *VRRP table on MC2-3600*



Local Redundancy

The local controllers at the aggregation layer also use VRRP instances to provide redundancy. However, a different redundancy model called active-active redundancy is used. In this model, the two local controllers terminate APs on two separate VRRP VIP addresses. Each Dell controller is the active local controller for one VIP address and the standby local controller for the other VIP. The controllers share a set of APs and divide the load among them. The APs are configured in two different AP groups, each with a different VIP as the LMS IP address.

Figure 20 *Active-active redundancy*



When an active local controller becomes unreachable, the APs that are managed by that controller fail over to the standby controller for that VRRP instance. Under these conditions, one controller terminates the entire AP load in the network. Therefore each controller must have sufficient processing power and licenses to accommodate all of the APs that are served by the entire cluster. Though the controllers are designed to support 100% capacity, do not load the mobility controllers past the 80% capacity so that the network is more predictable and allows headroom. Dell recommends that each mobility controller be run at only 40% capacity, so that when a failover occurs, the surviving mobility controller carries only an 80% load. This load gives the mobility controller the room to operate under the failover conditions for a longer period of time.

In this model, preemption should be disabled so that APs are not automatically forced to fail back to the original primary controller after it recovers. Whenever an AP fails over to a different controller, all the clients served by that AP get disconnected. So if a controller malfunctions and reboots constantly, then the APs served by that controller will “flap” between the original controller and standby controller if preemption is enabled. When preemption is disabled, the network administrator has sufficient time to troubleshoot the issue without this ping pong effect. The APs do not automatically fail back to the original controller, so this model requires that the mobility controller is sized appropriately to carry the entire planned failover AP capacity for an extended period of time.

Table 7 summarizes the VRRP instances used for local redundancy in the example network.

Table 7 *VRRP Instances Used for Local Redundancy*

VRRP ID	VRRP IP	Active Controller	Standby Controller
7	10.169.145.7	LC1-6000 (Priority 110)	LC2-6000 (Priority 100)
8	10.169.145.8	LC2-6000 (Priority 110)	LC1-6000 (Priority 100)

CLI Configuration

LC1-6000

```
!
vrrp 7
  priority 110
  ip address 10.169.145.7
  description "intial-primary-7"
```

```
  vlan 145
  no shutdown
!
vrrp 8
  ip address 10.169.145.8
  description "initial-standby-8"
  vlan 145
  no shutdown
!
```

LC2-6000

```
!
vrrp 7
 ip address 10.169.145.7
 description "initial-standby-7"
 vlan 145
  no shutdown
!
vrrp 8
 priority 110
 ip address 10.169.145.8
 description "initial-primary-8"
 vlan 145
  no shutdown
!
```

WebUI Screenshot

Figure 21 *VRRP-7 on LC1-6000*

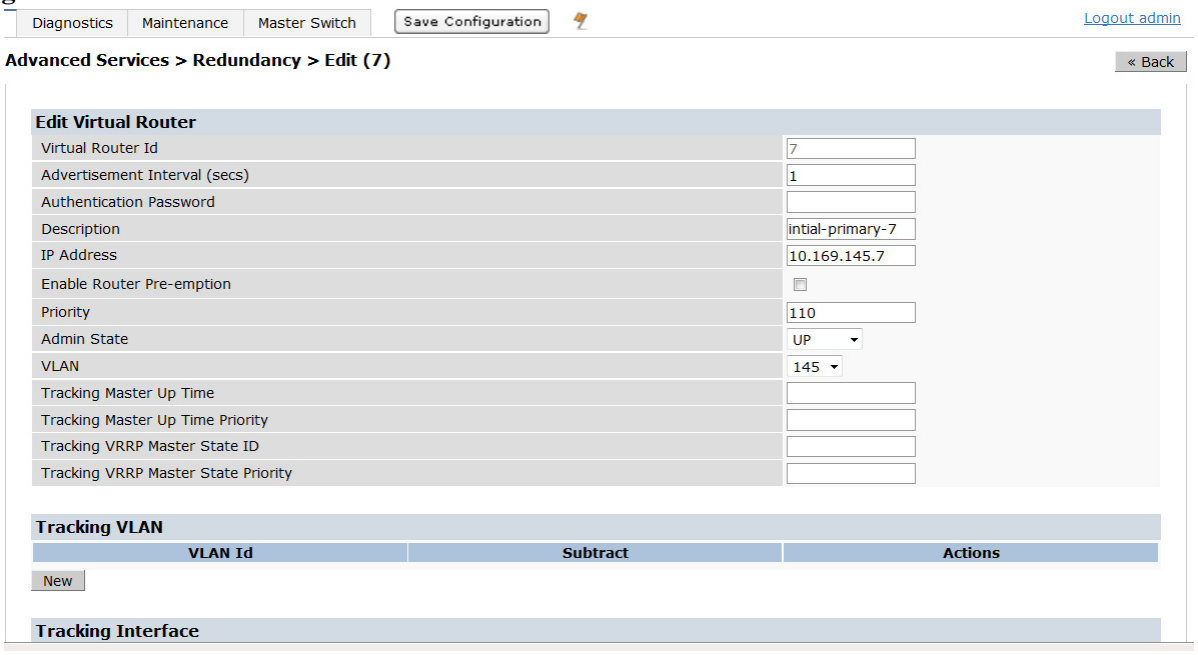


Figure 22 *VRRP-8 on LC1-6000*

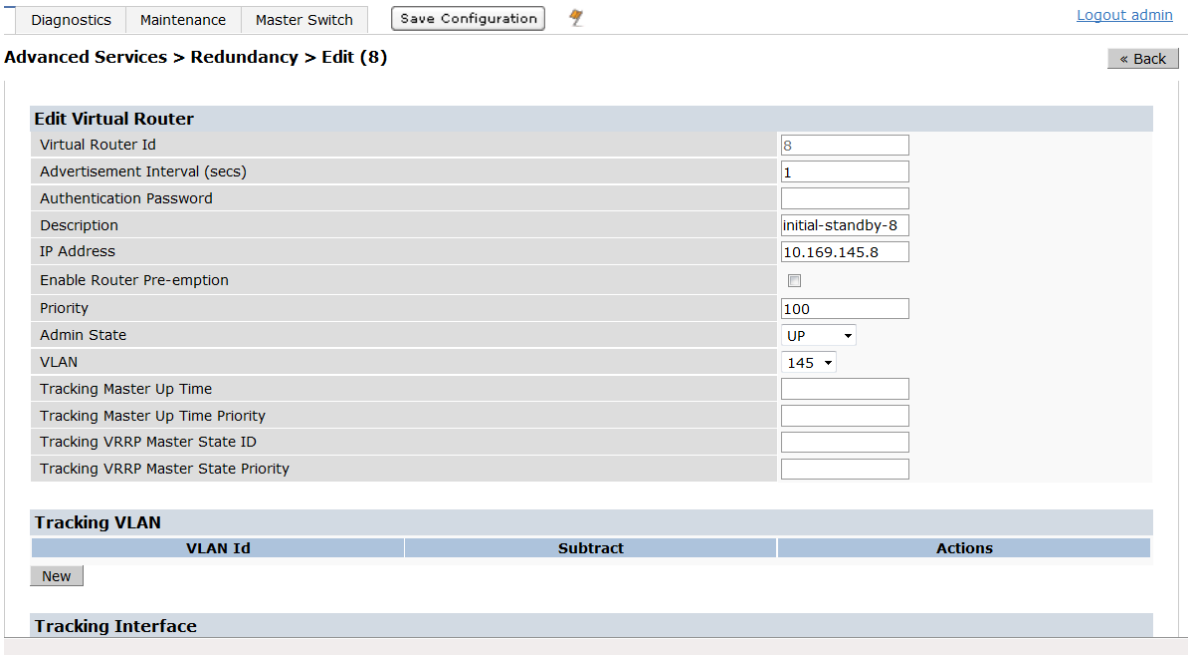


Figure 23 *VRRP table on LC1-6000*

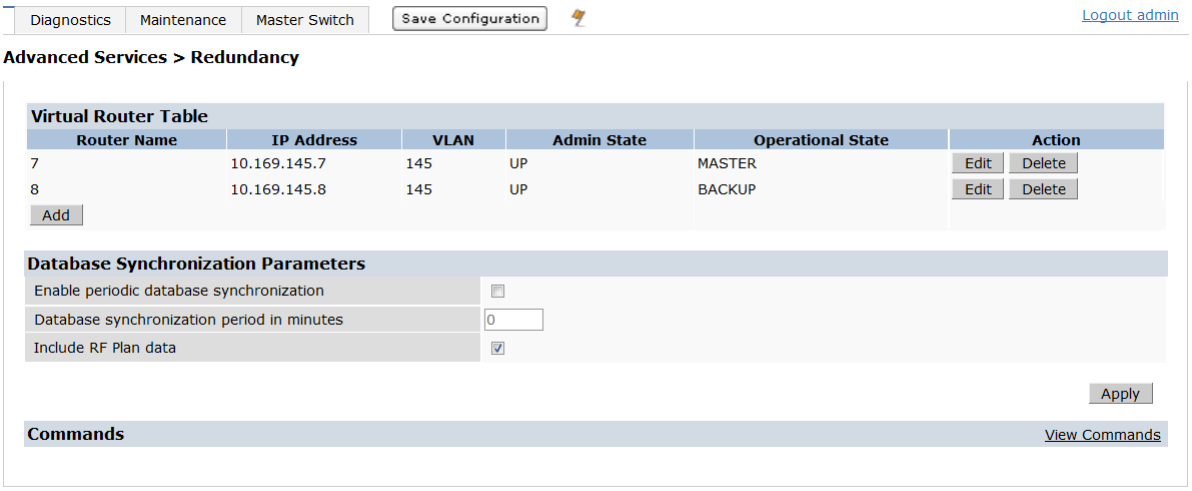


Figure 24 *VRRP-7 on LC2-6000*

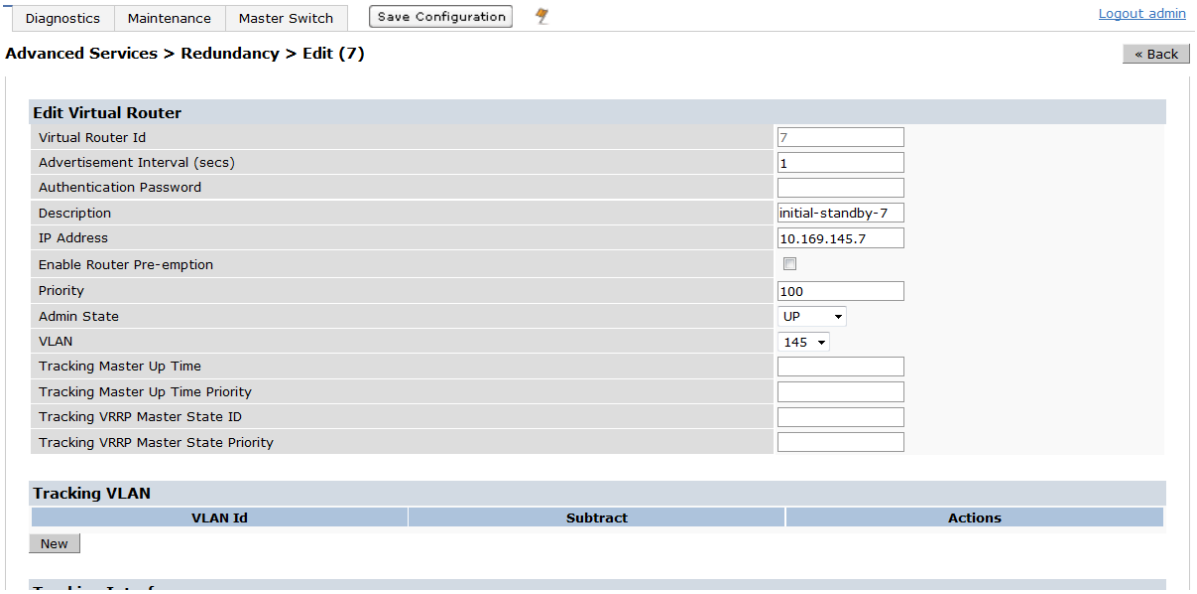


Figure 25 *VRRP-8 on LC2-6000*

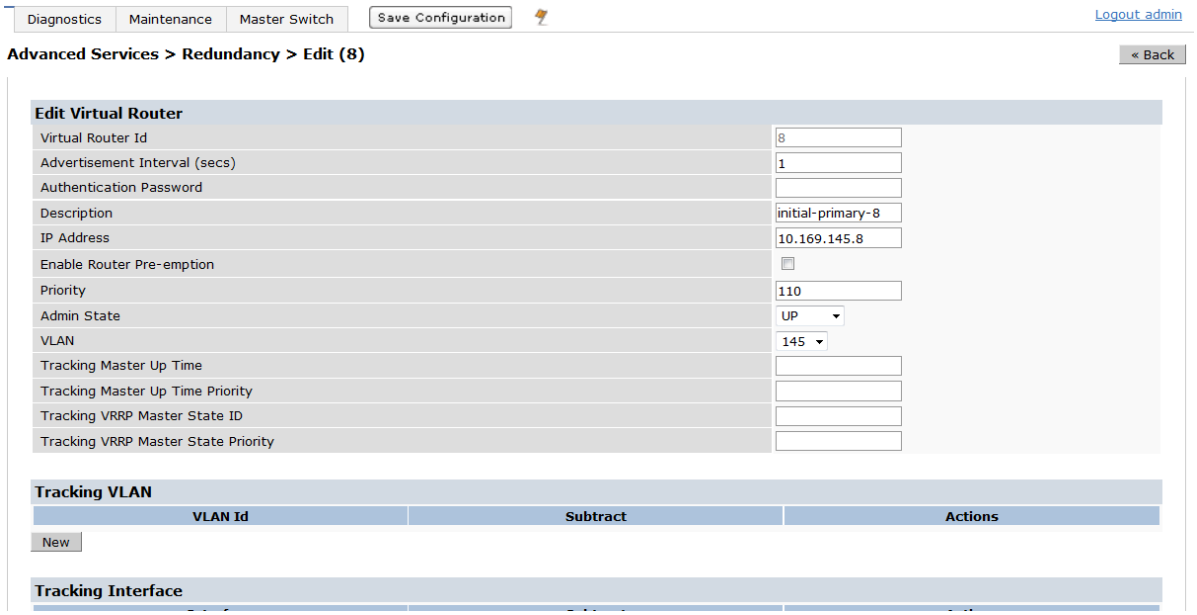
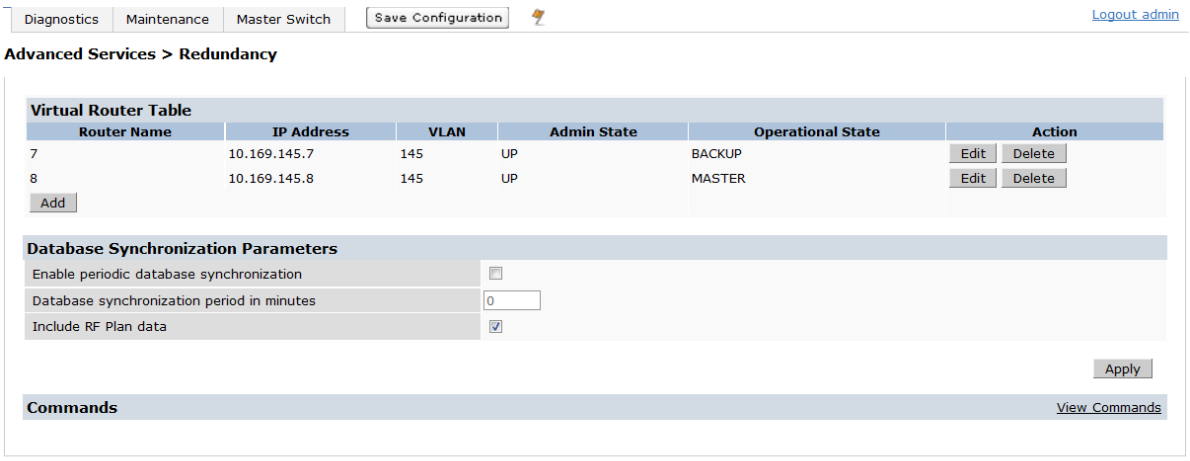


Figure 26 *VRRP table on LC2-6000*



Chapter 6: User Roles, Profiles, and AP Groups

In the Dell user-centric network, every client is associated with a user role. The user roles that are enforced through the firewall policies determine the network privileges of a user. A policy is a set of rules that applies to the traffic that passes through the Dell devices. The rules and policies are processed in a top-down fashion, so the position of a rule within a policy and the position of a policy within a role determine the functionality of the user role. When you construct a role, you must put the rules and policies in the proper order.

The PEFNG license is essential to exploit the identity-based security features on the Dell controller. The PEFNG license also adds a set of predefined policies on the controller, which can be used or modified as required.

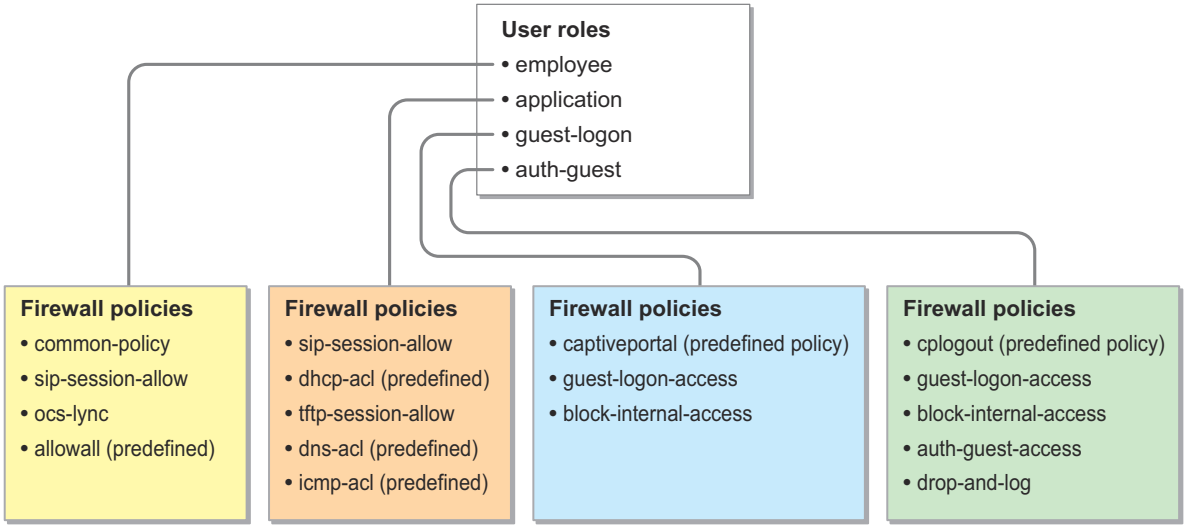
NOTE: Modifying the predefined policies is not recommended. If necessary, create a new policy that depicts the predefined rule and then customize it.

The type of user roles and polices vary between organizations and the example network defines roles and policies that are implemented in most cases. In the example network, the following roles are used:

- employee role
- application role
- guest-logon role
- auth-guest role

Figure 27 summarizes the user roles used in the example network and all the policies associated with each of those roles.

Figure 27 *User roles used in the example network*



Alias

The Alias feature in the Dell PowerConnect W-Series ArubaOS can be used to group several hosts or networks. Use this option when several rules have protocols and actions common to multiple hosts or networks. An alias simplifies

a firewall policy by reducing the number of ACL entries. The alias allows IP addresses to be added by host, network, or range. When the invert parameter of an alias is enabled, the rules that use that alias are applied to all the IP addresses except those specified in the alias. For more information about alias, see the *Dell PowerConnect W-Series ArubaOS 6.1 User Guide* available at support.dell.com/manuals.

Table 8 lists the aliases that are used in the example network.

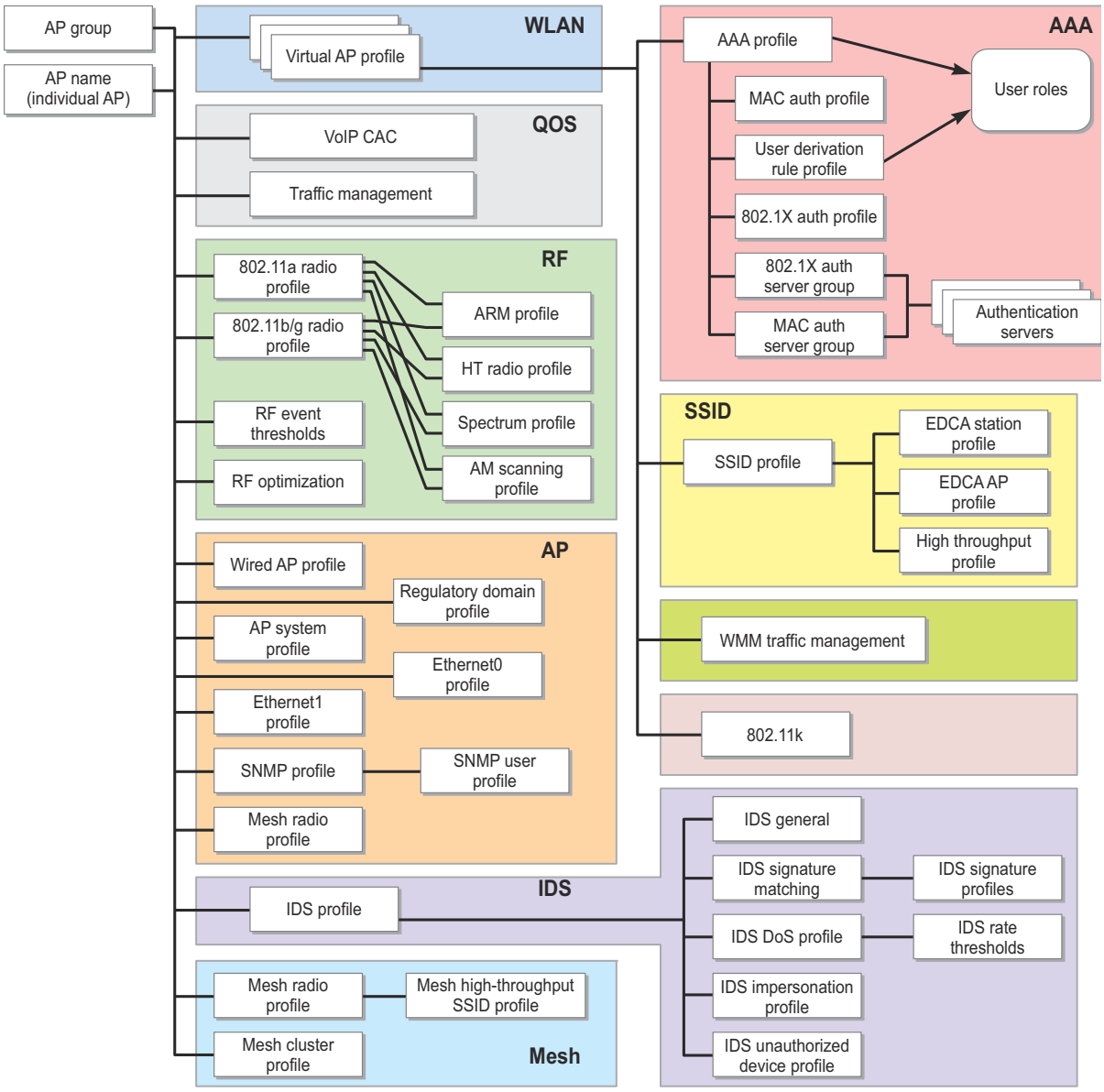
Table 8 *Aliases*

Alias Name	Purpose	IP Address/ Range
Public-DNS	Defines the public DNS servers	Host 8.8.8.8 216.87.84.209
Internal-Network	Defines the private IPv4 address range	Network 10.0.0.0/8 172.16.0.0/16 192.168.0.0/24
sip-server	Defines the SIP servers in the network	Host 10.169.130.20
tftp-server	Defines the TFTP servers in the network	Host 10.169.130.11
dns-servers	Defines the internal DNS servers	Host 10.169.130.4
ocs-lync	Defines the Microsoft Lync servers	Host 10.169.130.35
ClearPass-GuestConnect	Defines the ClearPass GuestConnect server	Host 10.169.130.50

Configuration Profiles

Configuration profiles allow different aspects of the Dell WLAN to be grouped into different configuration sets. Each profile is essentially a partial configuration. SSID profiles, radio profiles, and AAA profiles are just some of the available choices. For more information about these profiles, see the *Dell PowerConnect W-Series 802.11n Networks Validated Reference Design* and *Dell PowerConnect W-Series ArubaOS 6.1 User Guide*. Figure 28 shows an overview of the profile structure and high-level overview of an AP group.

Figure 28 *High-level overview of an AP group*



AP Groups

An AP group is a unique combination of configuration profiles. In general, all profiles can be assigned to an AP group to create a complete configuration. This flexibility in configuration allows arbitrary groupings of APs such as “All Headquarter APs”, “All Lobby APs”, or “All AMs”, with different configurations for each. Configuration profiles provide flexibility and convenience to wireless network managers who create AP groups. An AP group must include a minimum number of profiles, in particular, a VAP profile.

NOTE: Each AP, AM, SM, and RAP can be a part of only one AP group at any one time. This limitation eliminates the need to merge possibly contradictory configurations and prevents multiple VAPs with the same SSID from being enabled on the same physical AP.

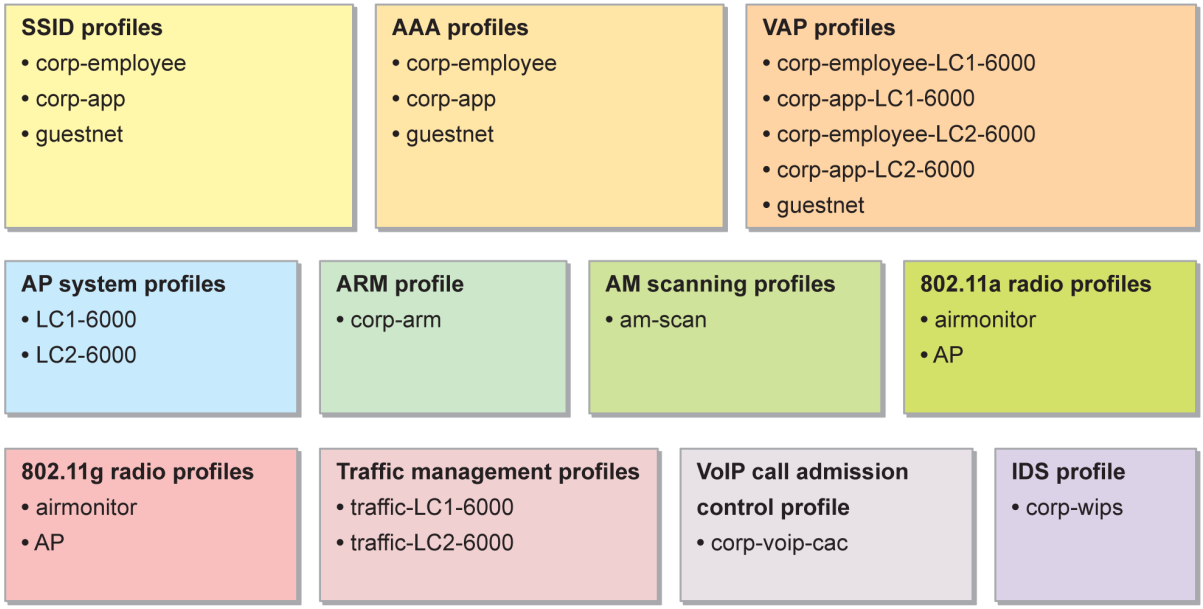
The example network uses the following four AP groups:

- AP-LC1-6000
- AM-LC1-6000

- AP-LC2-6000
- AM-LC2-6000

Figure 29 summarizes the configuration profiles used by these four AP groups in the example network. The chapters that follow explain how to configure each of these profiles and why they are necessary.

Figure 29 *All the profiles configured in the example network*



Chapter 7: AP Groups for Client Access

When you create an AP group for client access you create a functional WLAN for client access. To create an AP group for client access, you need to configure these:

- firewall policies and user roles (required)
- SSID profile (required)
- server groups, AAA profile (required)
- VAP profile (required)
- Adaptive Radio Management (ARM) profile (optional, but recommended)
- 802.11a radio profile (required)
- 802.11g radio profile (required)
- AP system profile (required)
- 802.11a traffic management profile (optional, but recommended)
- 802.11g traffic management profile (optional, but recommended)
- VoIP call admission control profile (optional, but recommended)
- IDS profile (optional, but recommended)

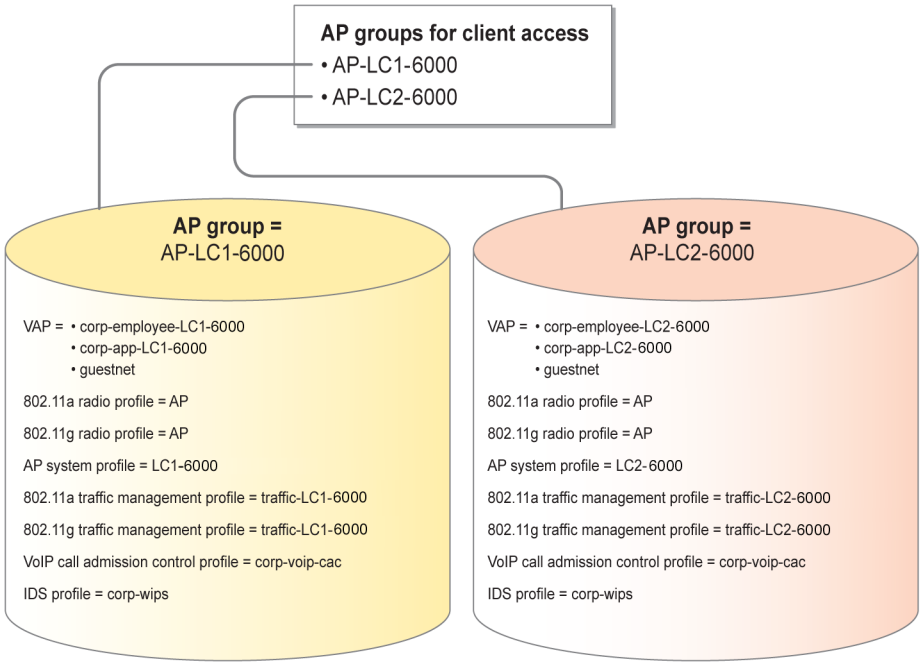
The following chapters explain the configuration of the AP-LC1-6000 and AP-LC2-6000 AP groups for client access. The AP-LC1-6000 AP group is used for all APs that must be managed by the LC1-6000 local controller. The AP-LC2-6000 AP group is used for all APs that must be managed by the LC2-6000 local controller.

The APs that belong to one of these two AP groups perform these actions:

- Broadcast employee, application, and guest SSIDs in both 2.4 GHz and 5 GHz bands.
- Participate in ARM and band steering.
- Terminate on VRRP-7 VIP if they are in the AP-LC1-6000 AP group or on VRRP-8 VIP if they belong to the AP-LC2-6000 AP group.
- Participate in prioritizing traffic based on SSID and WMM category.
- Participate in VoIP call admission control.
- Participate in wireless intrusion prevention.

Figure 30 summarizes the profiles used for the AP-LC1-6000 and AP-LC2-6000 AP groups.

Figure 30 *AP groups for client access*



Chapter 8: Configuring the Employee Role

Company employees can be granted a role based on their specific job function, department, domain, or they can be given a universal employee role. In certain organizations, users typically are placed in a single user role that has access to all internal and external resources.

The employee role used in the example network grants unrestricted access to the internal and external resources, but denies personal DHCP servers. The employee role is the default role assigned to clients after successful 802.1X authentication to the employee SSID. This role gives voice traffic priority over standard data traffic. All company employees and devices capable of 802.1X/EAP use the employee SSID.

Before you configure the employee role, first you must create the policies associated with it. The employee role in the example network uses the following policies:

- common
- sip-session-allow
- ocs-lync
- allowall (predefined)

Configuring the Common Policy

In most campus deployments, all users should be denied certain services, no matter what their roles. This common policy is used by the employee role to do the following things:

- Deny users from activating their personal DHCP servers on the network.
- Allow ping across the network.
- Allow DNS queries only to certain predefined DNS servers.

Remember, the order of rules within a policy determines the behavior of the policy.

Table 9 summarizes the rules used for the common policy.

Table 9 *Rules Used for the Common Policy*

Rule Number	Source	Destination	Service	Action	Purpose
1	User	Any	UDP min port = 68 max port = 68	Drop	This rule drops responses from a personal DHCP server, which prevents the clients from acting as DHCP servers.
2	Any	Any	Service svc-dhcp (udp 67 68)	Permit	This rule allows clients to request and discover a DHCP IP address over the network. The DHCP server on the network does not fall under the User category, so its response on port 68 is not dropped by the first rule. The first two rules guarantee that DHCP is processed only by legitimate DHCP servers on the network.
3	Any	Any	Service svc-icmp (icmp 0)	Permit	This rule allows ICMP (ping) across the internal network.
4	Any	Alias dns-servers	Service svc-dns (udp 53)	Permit	This rule allows DNS queries to the set of DNS servers defined in the dns-servers alias.

CLI Configuration

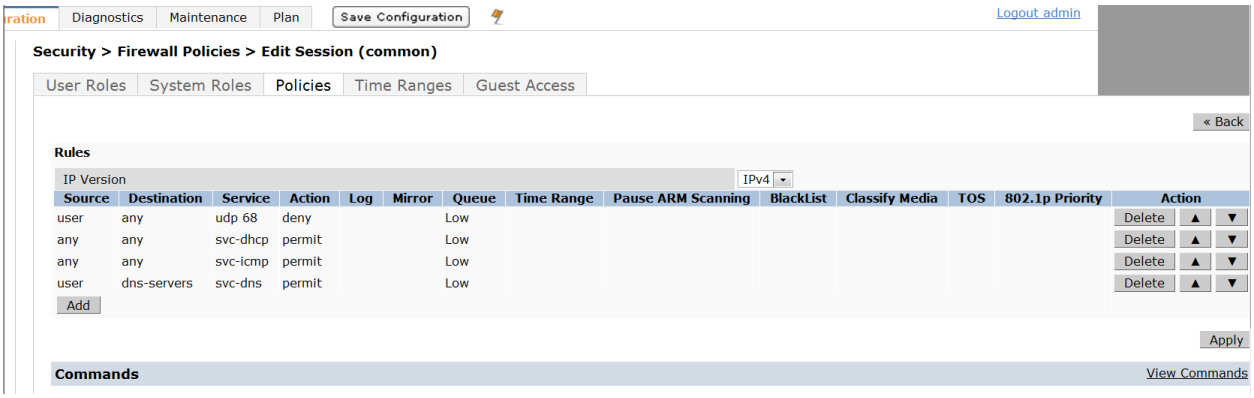
MC1-3600

```
!
ip access-list session common
user any udp 68 deny
any any svc-dhcp permit
any any svc-icmp permit
user  alias dns-servers svc-dns permit
!
```

WebUI Screenshot

MC1-3600

Figure 31 *Common policy*



Configuring the sip-session-allow Policy

The sip-session-allow policy prioritizes SIP traffic and allows SIP services only between the user and the corporate PBX and servers that provide voice service. If the organization supports protocols such as NOE from Alcatel Lucent, H.323, SCCP, Vocera, and others for voice communication, policies should be created to prioritize them.

Table 10 summarizes the rules used for the sip-session-allow policy.

Table 10 *Rules Used for the sip-session-allow Policy*

Rule Number	Source	Destination	Service	Action	Queue	Purpose
1	user	Alias sip-server	Service svc-sip-udp	permit	high	Allows SIP sessions between users and SIP servers using the UDP protocol
2	user	Alias sip-server	Service svc-sip-tcp	permit	high	Allows SIP sessions between users and SIP servers using the TCP protocol
3	Alias sip-server	user	Service svc-sip-udp	permit	high	Allows SIP sessions between SIP servers and users using the UDP protocol
4	Alias sip-server	user	Service svc-sip-tcp	permit	high	Allows SIP sessions between SIP servers and users using the TCP protocol

CLI Configuration

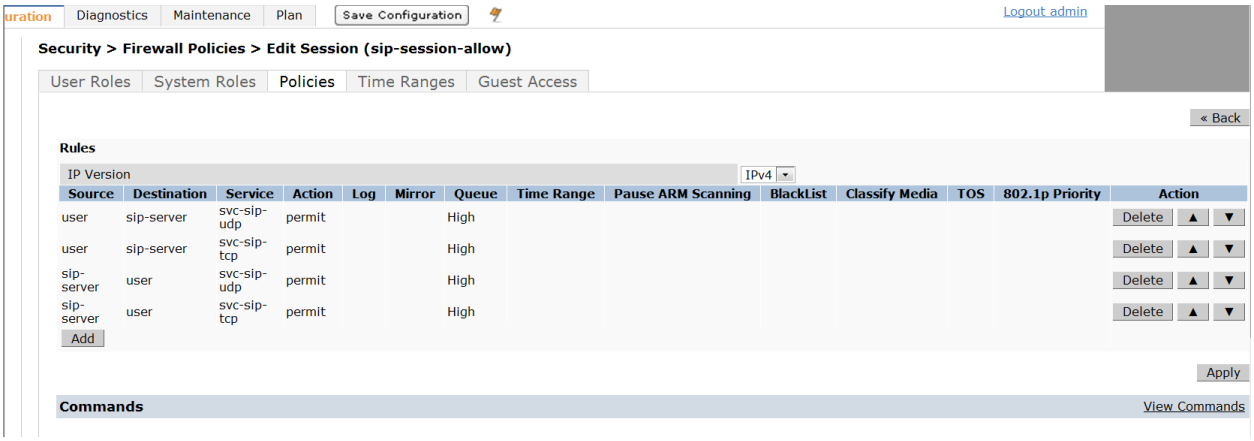
MC1-3600

```
!
ip access-list session sip-session-allow
 user  alias sip-server svc-sip-udp permit queue high
 user  alias sip-server svc-sip-tcp permit queue high
 alias sip-server user svc-sip-udp permit queue high
 alias sip-server user svc-sip-tcp permit queue high
!
```

WebUI Screenshot

MC1-3600

Figure 32 *sip-session-allow policy*



Configuring the ocs-lync Policy

Many organizations use Microsoft Office Communications Server or Microsoft Lync Server for voice, instant messaging, and conferencing. These Microsoft products use SIP over TLS for signaling. ArubaOS performs a deep packet inspection on traffic established over a secure channel to identify the voice and video sessions. This deep packet inspection of encrypted traffic allows the Dell PowerConnect W-Series to provide QoS for the voice or video sessions established even over the secure layers such as TLS or IP Sec. The *classify media* option enables this support.

Microsoft OCS/Lync uses TCP on port 5060/5061 for communication between the Microsoft OCS/Lync server and Office Communicator /Lync client. So, the ocs-lync policy is constructed to perform deep packet inspection only on the TCP traffic on ports 5060/5061.

Table 11 summarizes the rules used for the ocs-lync policy.

Table 11 *Rules Used for the ocs-lync Policy*

Rule Number	Source	Destination	Service	Action	Queue	Classify Media	Purpose
1	User	Alias ocs-lync	Service svc-sips (tcp 5061)	permit	high	Enabled	This rule performs deep packet inspection and prioritization of encrypted voice, and video sessions of OCS/Lync.
2	User	Alias ocs-lync	Service svc-sip-tcp (tcp 5060)	Permit	high	Enabled	
3	Alias ocs-lync	any	Service svc-sips (tcp 5061)	Permit	high	Enabled	
4	Alias ocs-lync	any	Service svc-sip-tcp (tcp 5060)	permit	high	Enabled	

NOTE: Selecting any for the service field and setting the classify media flag, has an impact on performance because it turns on deep packet inspection for all traffic types. Choose this option only for services that require it.

CLI Configuration

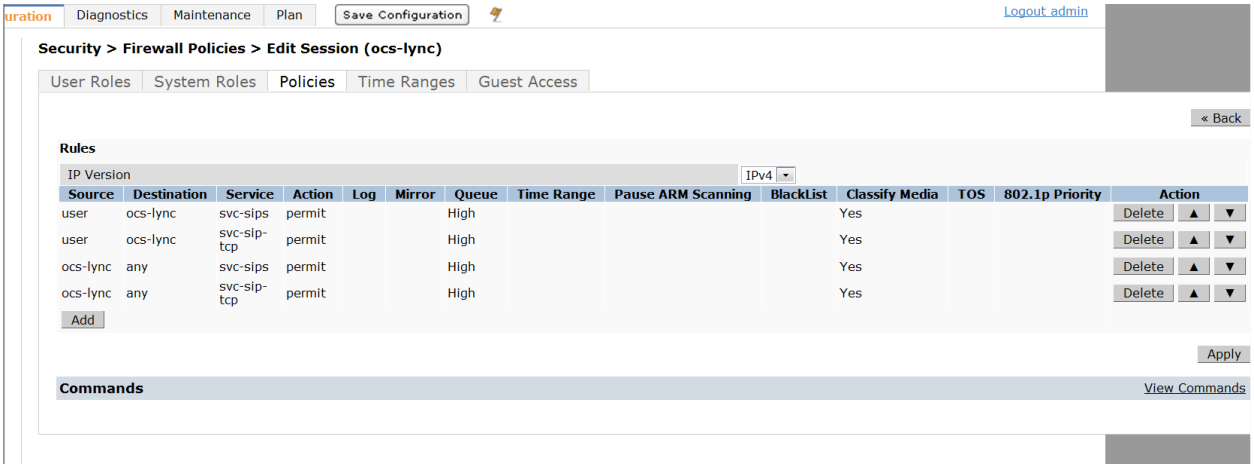
MC1-3600

```
!
ip access-list session ocs-lync
 user  alias ocs-lync svc-sips permit classify-media queue high
 user  alias ocs-lync svc-sip-tcp permit classify-media queue high
 alias ocs-lync any svc-sips permit classify-media queue high
 alias ocs-lync any svc-sip-tcp permit classify-media queue high
!
```

WebUI Screenshot

MC1-3600

Figure 33 *ocs-lync policy*



Configuring the Employee Role

After all the required policies are configured, place the required firewall policies in correct order to create the employee role. Remember, the order of policies determines the behavior of a user role.

Table 12 summarizes the policies in the employee role.

Table 12 *Policies in the Employee Role*

Policy Number	Policy Name	Purpose
1	common	This policy denies personal DHCP servers but allows legitimate DHCP and DNS services. For details, see "Configuring the Common Policy" on page 33.
2	sip-session-allow	This policy gives voice traffic priority using the high priority queue. For details, see "Configuring the sip-session-allow Policy" on page 35.
3	ocs-lync	This policy gives priority to encrypted voice and video sessions used by Microsoft OCS and Lync services. For details, see "Configuring the ocs-lync Policy" on page 36.
4	allowall (predefined)	This policy allows any service from any source to any destination.

CLI Configuration

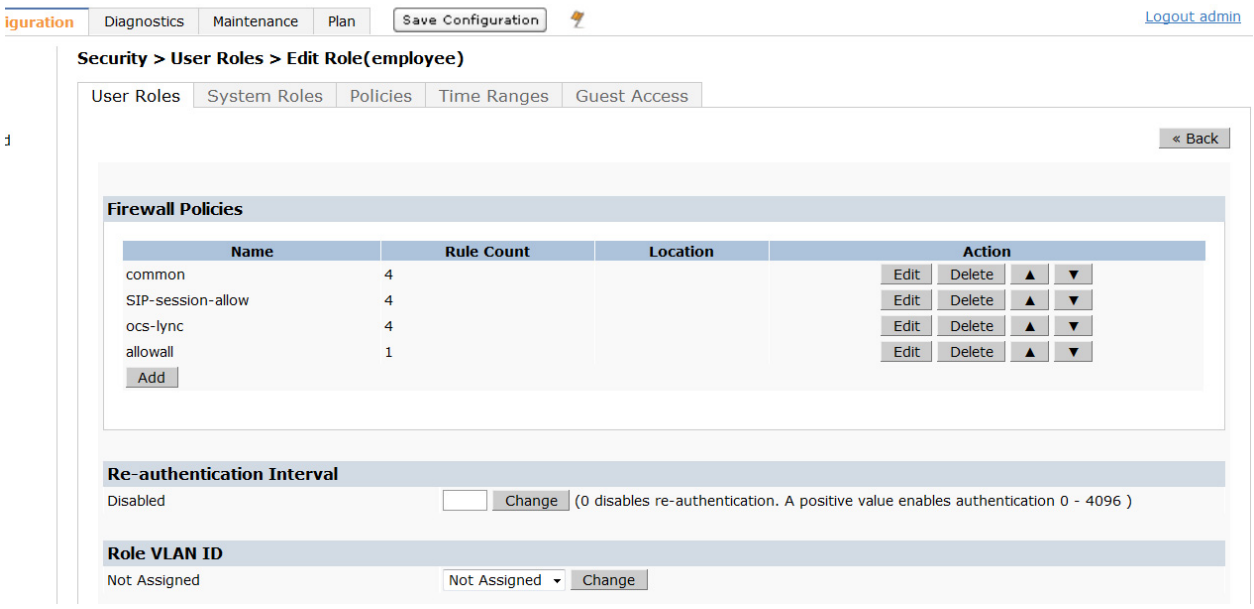
MC1-3600

```
!
user-role employee
 access-list session common
 access-list session SIP-session-allow
 access-list session ocs-lync
 access-list session allowall
!
```

WebUI Screenshot

MC1-3600

Figure 34 *Employee role*



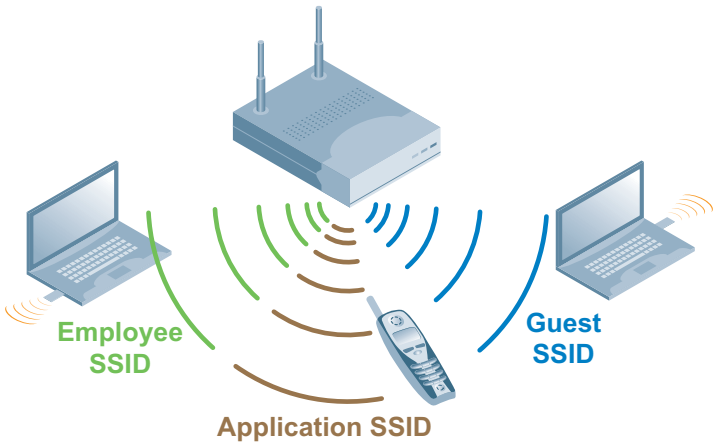
Chapter 9: Employee VAP Profiles

A typical home AP advertises only one SSID, so even with a dual-radio AP, only two WLANs can be formed. Ideally, in these situations the number of physical APs is proportional to the number of WLANs supported. Dell PowerConnect W-Series solves this issue with the concept of virtual access points (VAPs). VAPs are logical entities that are present within a physical AP.

Physical Dell APs, unlike typical home APs, are often configured to appear as more than one physical AP. This configuration provides the necessary authentication and encryption combinations without collocating excessive amounts of APs in the same physical area.

The VAPs share the same channel and power settings on the radio, but each appears as a separate AP with its own SSID (ESSID) and MAC address (BSSID).

Figure 35 *A typical set of VAPs on one physical AP*



Dell PowerConnect W-Series supports up to eight BSSIDs per radio on the AP, with a maximum of 16 VAPs per physical AP. The maximum total number of BSSIDs that are supported across the WLAN is a function of the mobility controller model.

CAUTION: Dell does not recommend running an AP with the maximum number of VAPs available. Each VAP acts like a real AP and is required to beacon like any other AP. This beaconing consumes valuable airtime that would otherwise be used by clients to transmit data on the channel. Dell recommends that you leverage the smaller numbers of SSIDs and user roles and deploy a new SSID only when a new encryption or authentication type is required.

NOTE: The BSSIDs assigned to each of the 16 possible SSIDs on a physical AP are generated from the MAC address of the physical AP. A total of 16 BSSIDs are generated by the algorithm. The BSSID assigned to each SSID is random. Whenever an AP reboots the BSSID to SSID mapping may change. In certain situations a SSID may be temporarily disabled for maintenance, when this SSID is enabled again, the BSSID assigned to it might not be the same as before.

A VAP profile is a container that holds an AAA profile, SSID profile, 802.11k profile, and WMM traffic management profile. At minimum, each VAP profile must have an AAA and SSID profile. The VAP profile also has other configurable features, such as band steering, dynamic multicast optimization, fast roaming, and DoS prevention.

Table 13 summarizes the VAP profiles used in the example network.

Table 13 *VAP Profiles Used in the Example Network*

VAP Profile	AP Group	VLAN/ VLAN Pool
Corp-Employee-LC1-6000	AP-LC1-6000	pool-7
Corp-App-LC1--6000	AP-LC1-6000	pool-7
Corp-Employee-LC2-6000	AP-LC2-6000	pool-8
Corp-App-LC2-6000	AP-LC2-6000	pool-8
guestnet	AP-LC1-6000, AP-LC2-6000	900

Configuring the SSID Profiles

Service Set Identifier (SSID) is the network or WLAN that any client sees. A SSID profile defines parameters, such as name of the network, authentication type for the network, basic rates, transmit rates, SSID cloaking, and certain WMM settings for the network.

Dell PowerConnect W-Series offers different flavors of the Advanced Encryption Standard (AES), Temporal Key Integrity Protocol (TKIP), and wired equivalent privacy (WEP) encryption. AES is the most secure and recommended encryption method. Most modern devices are AES capable and AES should be the default encryption method. Use TKIP only when devices that are not AES capable are present. In these situations, use a separate SSID for devices that are only capable of TKIP. It is important to understand that several vulnerabilities have been reported with TKIP. Avoid using WEP, because it can be cracked in less than 5 minutes with generally available tools. Dell also supports a host of authentication methods such as 802.1X, captive portal, PSK, and WEP.

Configuring the Employee SSID Profile

By default, all employees and corporate devices should connect to the employee SSID. The use of 802.1X with a backend RADIUS server and AES encryption makes this the most secure network. For more information about authentication types, encryption methods, and role derivation on the Dell Mobility Controller for Wi-Fi Protected Access® 2 (WPA2™), see the *Dell PowerConnect W-Series 802.11n Networks Validated Reference Design*.

Configuring Wi-Fi Multimedia

Wi-Fi Multimedia™ (WMM®) is a Wi-Fi Alliance® certification program that is based on the IEEE 802.11e amendment. WMM ensures QoS for latency-sensitive traffic in the air. WMM divides the traffic into four queues or access categories:

- voice
- video
- best effort
- background

The traffic is prioritized based on the queue it belongs to. The order of priority is voice > video > best effort > background. Like WMM for QoS in air, QoS on the wired side of the network is dictated by the DiffServ Code Point (DSCP) and 802.1p tagging. To ensure end-to-end QoS on the network, consider these requirements:

- The DSCP tags should translate to appropriate WMM access categories and vice-versa. The Dell PowerConnect W-Series infrastructure ensures this translation between WMM and DSCP/802.1P markings when the traffic moves across wired and wireless mediums.

- All devices in the network should be capable of and configured for QoS support. The LAN that is between the AP and the mobility controller must recognize and prioritize DCSP-marked traffic through the network. Similarly, the core must respect the DSCP marks from the multimedia servers.

For more information about the mapping between WMM access categories, DSCP tags and other QoS functionalities, see the *Dell PowerConnect W-Series 802.11n Networks Validated Reference Design*.

In the example network, the WMM parameter is enabled on the employee SSID to prioritize latency-sensitive traffic, such as voice and video, over the standard data traffic. The DSCP-to-WMM mapping is a configurable parameter that is available within the SSID profile. In the example network, the DSCP-to-WMM mapping values are set to the defaults. The Dell default DSCP-to-WMM mapping values match the default DSCP settings of most vendors. Alter the defaults only if they vary from your existing DSCP settings.

Table 14 summarizes the Corp-Employee SSID profile.

Table 14 *Corp-Employee SSID Profile*

SSID Profile	Network Name (SSID)	Authentication	Encryption	WMM	Purpose
Corp-Employee	Employee	WPA2	AES	Enabled	All employees and corporate devices that support 802.1X will be in this SSID.

CLI Configuration

MC1-3600

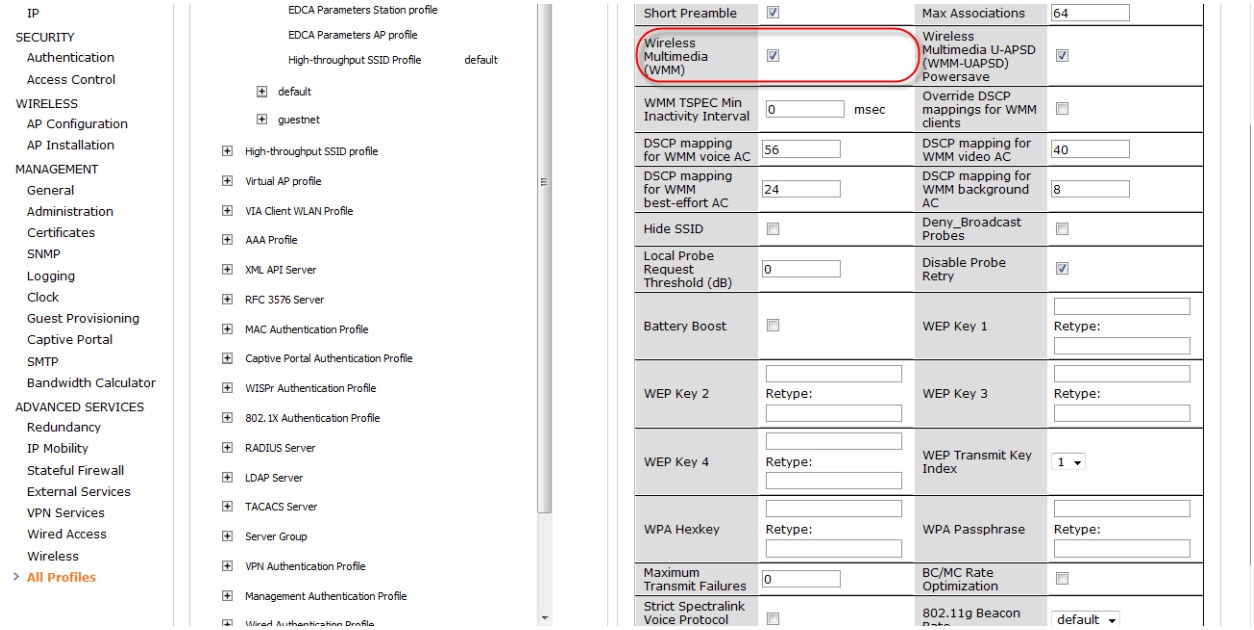
```
!

wlan ssid-profile "Corp-Employee"
   essid "Corp-Employee"
   opmode wpa2-aes
   wmm
!
```

WebUI Screenshot

MC1-3600

Figure 36 *Corp-Employee SSID*

Figure 37 *WMM enabled for Corp-Employee SSID (available on the Advanced tab of the SSID profile)*



Configuring the AAA Profiles

The AAA profiles define how users are authenticated. The AAA profile determines the user role for unauthenticated clients (initial role) and the user role to be applied after successful authentication (default role) based on the authentication type. The AAA profile also defines the server group that is used for the defined authentication method and RADIUS accounting. For example, consider two different locations, Sunnyvale and New York, where the employee WLAN should be available and each location has its own RADIUS server. The employee SSID profile is the same, but there will be two AAA profiles: one for Sunnyvale and one for New York, because two different servers exist for authentication. So, APs in Sunnyvale will have a different VAP for the employee WLAN than APs in New York.

Authentication Server and Server Groups

For authentication, ArubaOS can use the internal database or external authentication servers such as RADIUS, LDAP, TACAS+, and Windows server. A server group is a collection of servers used for authentication. In case of 802.1X authentication, the external RADIUS server or servers used for 802.1X authentication for a particular WLAN are grouped together as a server group. By default, the first server on the list is used for authentication unless it is unavailable. A server group can have different authentication servers. For example, you can create a server group that uses an LDAP server as a backup for a RADIUS server.

Configuring the NPS Server Group for 802.1X Authentication

The example network uses the server group named NPS for 802.1X authentication of corporate users. A RADIUS server called NPS1 is defined and added to the NPS server group. For details on 802.1X/EAP process, see the *Dell PowerConnect W-Series 802.11n Networks Validated Reference Design*.

NOTE: If the RADIUS server is configured to return specific attributes for the users after authentication, then the server-derived role that corresponds to the returned attributes can be configured under server groups. For information about configuring a server-derived role, see the *Dell PowerConnect W-Series ArubaOS 6.1 User Guide* available at support.dell.com/manuals.

CLI Configuration

MC1-3600

```
!
aaa authentication-server radius "NPS1"
  host "10.169.130.20"
  key **********
  timeout 30
!

aaa server-group "NPS"
 auth-server NPS1
!
```

WebUI Screenshot

MC1-3600

Figure 38 *NPS1 RADIUS Server*

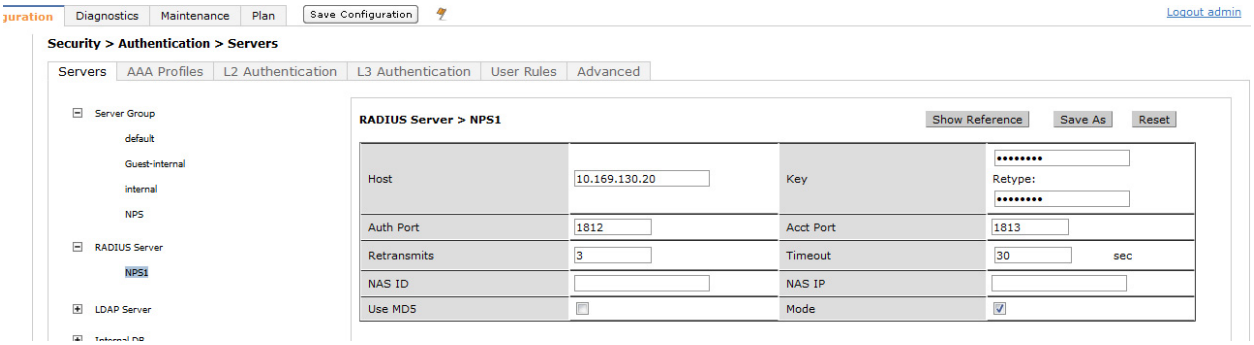
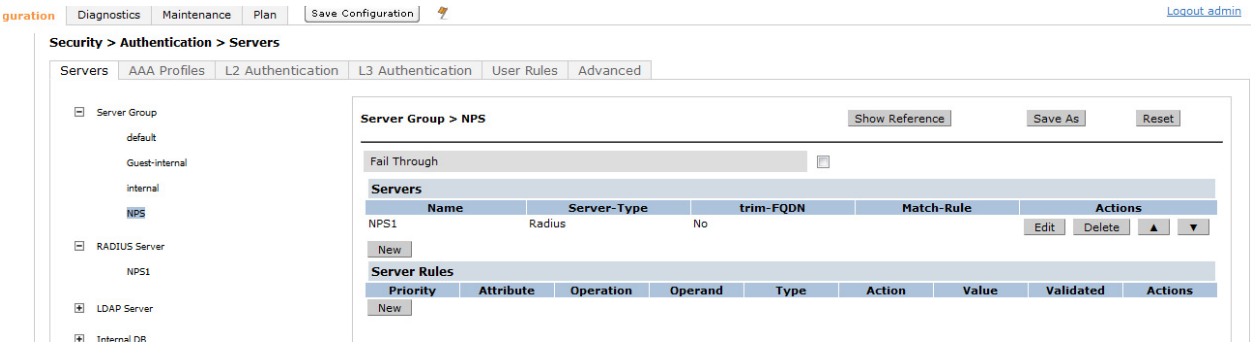


Figure 39 *NPS sever group*



Configuring the Employee AAA Profile

The AAA profile named corp-employee is used for the employee WLAN. First create an AAA profile called corp-employee and then configure the following parameters in it:

- Default role for 802.1X authentication: *employee role* (see , “Chapter 8: Configuring the Employee Role” on page 37).
- 802.1X authentication server group: NPS
- 802.1X profile:
  - Create the corp-employee-dot1x 802.1X profile.
  - Enable termination. (By default the Termination EAP-Type is eap-peap and Termination Inner EAP Type is eap-mschapv2.)

NOTE: Dell recommends 802.1X termination on the controller. This feature, also known as AAA FastConnect™, offloads the cryptographic portion of 802.1X/EAP authentication exchange to the controller, which reduces the load on the RADIUS server. AAA FastConnect permits several hundred authentication requests per second to be processed, which increases authentication server scalability. This feature is very useful when the authentication server is not 802.1X capable, such as an LDAP server. For details about AAA FastConnect, see the *Dell PowerConnect W-Series 802.11n Networks Validated Reference Design*.

CLI Configuration

MC1-3600

```
!
aaa authentication dot1x "corp-employee-dot1x"
!

!
aaa profile "corp-employee"
  authentication-dot1x "corp-employee-dot1x"
  dot1x-default-role "employee"
  dot1x-server-group "NPS"
!
```

WebUI Screenshot

MC1-3600

Figure 40 *corp-employee-dot1x 802.1X authentication profile*

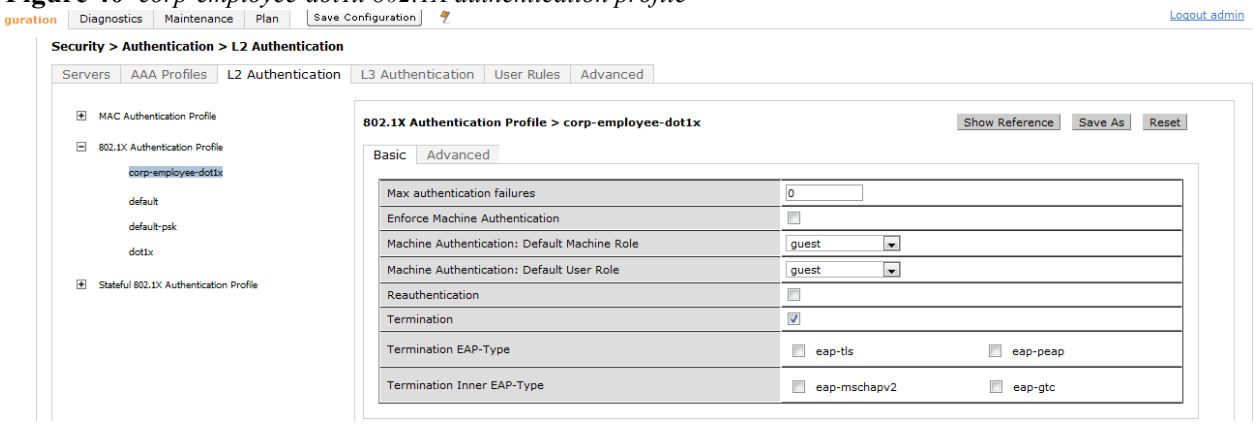
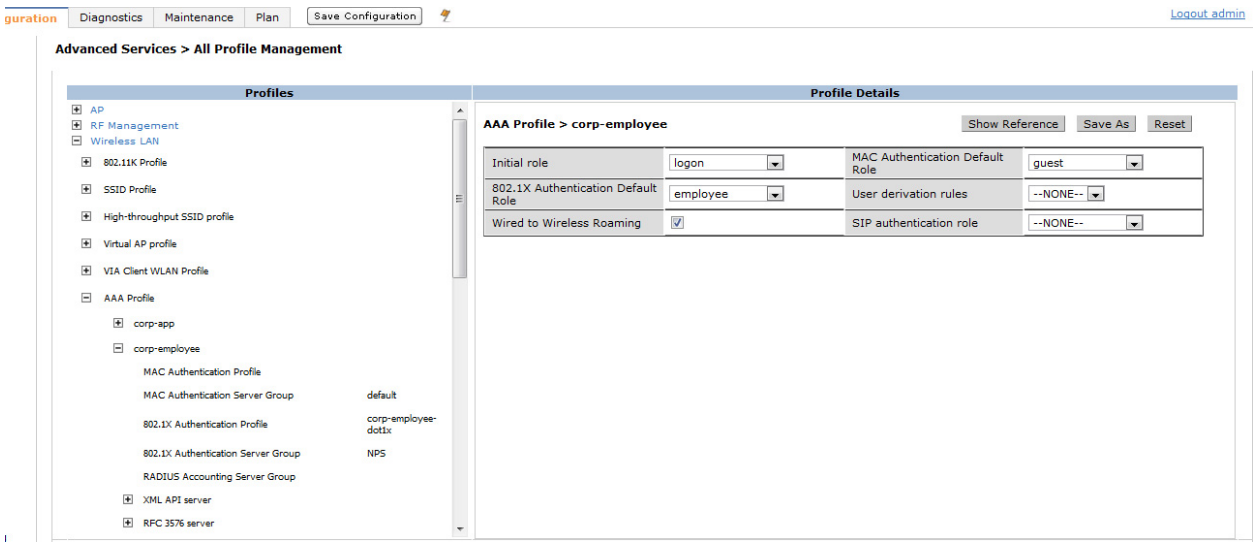


Figure 41 *corp-employee AAA profile*



Configuring the Employee VAP Profiles

Band steering, which is a feature of ARM, identifies dual-band-capable clients and can encourage or force them to move to the 5 GHz band. The 5 GHz band has more channels, more bandwidth availability, and fewer sources of

interference than the 2.4 GHz band. Dell recommends using band steering. Figure 42 summarizes the employee VAPs used in the example network.

Figure 42 *Employee VAP profiles*

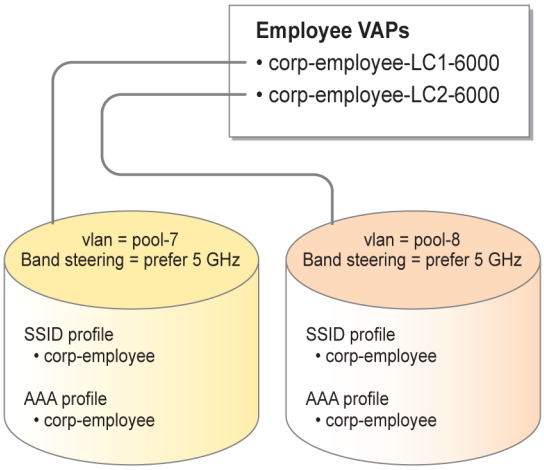


Table 15 lists the parameters that are configured for the Corp-Employee-LC1-6000 and Corp-Employee-LC2-6000 VAP profiles.

Table 15 *Employee VAP Profiles*

VAP Profile	VLAN	Band Steering	AAA Profile	SSID Profile
Corp-Employee-LC1-6000	pool-7	-Enabled; -Prefer 5 GHz	corp-employee	Corp-Employee
Corp-Employee-LC2-6000	pool-8	-Enabled; -Prefer 5 GHz	corp-employee	Corp-Employee

CLI Configuration

MC1-3600

```
!
wlan virtual-ap "Corp-Employee-LC1-6000"
   aaa-profile "corp-employee"
   ssid-profile "Corp-Employee"
   vlan pool-7
   band-steering
   wmm-traffic-management-profile "corp-wmm"
!

wlan virtual-ap "Corp-Employee-LC2-6000"
   aaa-profile "corp-employee"
   ssid-profile "Corp-Employee"
   vlan pool-8
   band-steering
   wmm-traffic-management-profile "corp-wmm"
!
```

WebUI Screenshot

MC1-3600

Figure 43 *Corp-Employee-LC1-6000 VAP profile*

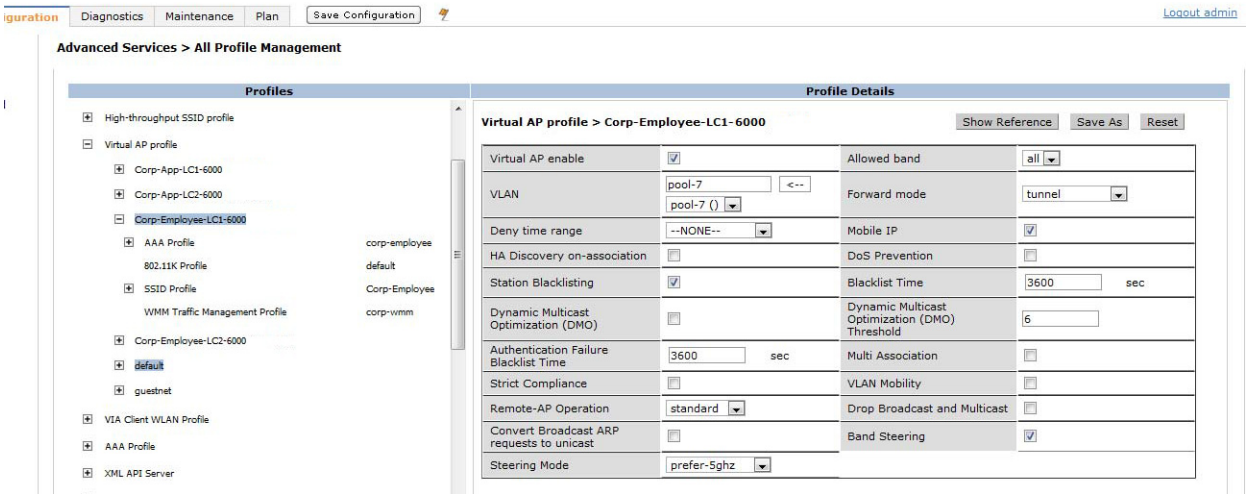
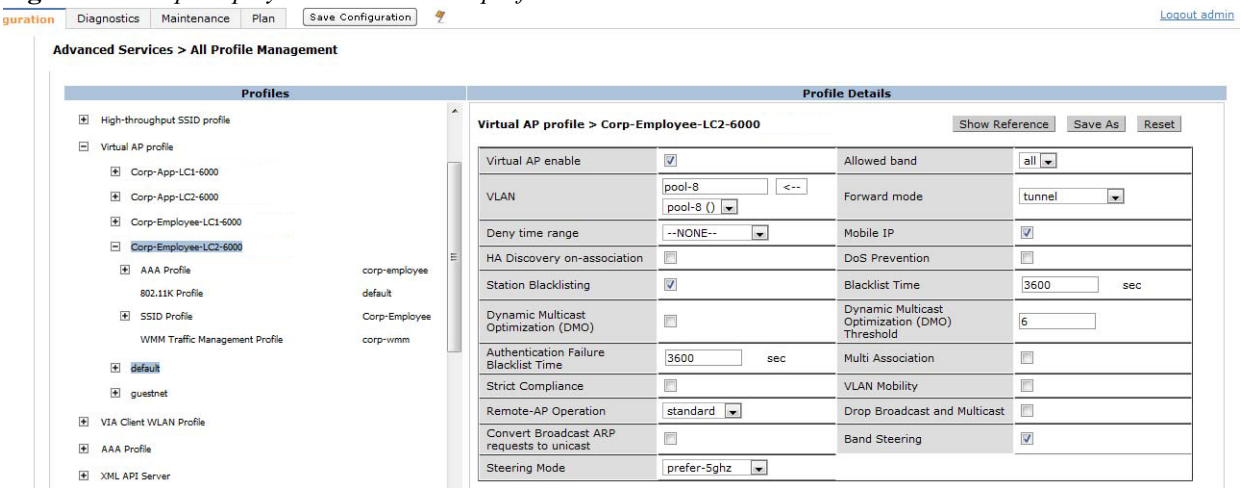


Figure 44 *Corp-Employee-LC2-6000 VAP profile*



Chapter 10: Configuring the Application Role and VAP Profiles

Certain devices, such as legacy handheld scanners and IP video cameras, are not capable of 802.1X/EAP and use PSK for authentication. In cases where PSK has be to supported to accommodate the devices that do not support 802.1X, you must create a separate user role for those applications and devices. Unlike the employee role, this user role should be restricted only to the services and servers required by such devices.

The example network has some SIP phones that are not capable of 802.1X and use the application SSID. These phones use the SIP protocol and need TFTP to download configurations. These phones in the example network need only SIP, DHCP, TFTP, DNS, and ICMP services to operate. Different devices use different protocols for operation. The services that the devices require depend on the vendor. Contact your device vendor to determine the services that are needed for your device operation.

The example network assigns the application user role to the devices that associate to the application SSID. The application role allows access only to the SIP, DHCP, TFTP, DNS, and ICMP services. The application role ensures that the devices that associate to the application SSID access only the required services and servers.

Before you configure the application role, first create the policies that are associated with it. The application role in the example network uses the following policies:

- sip-session-allow (For details, see, “Chapter 8: Configuring the Employee Role” on page 35.)
- dhcp-acl (predefined)
- tftp-session-allow
- dns-acl (predefined)
- icmp-acl (predefined)

Configuring the tftp-session-allow Policy

The tftp-session-allow policy allows only TFTP services between the user and TFTP servers.

Table 16 summarizes the rules used for the tftp-session-allow policy.

Table 16 *Rules Used for the tftp-session-allow Policy*

Rule Number	Source	Destination	Service	Action	Purpose
1	user	Alias tftp-server	Service svc-tftp	permit	Allows TFTP sessions between the user and TFTP servers.

CLI Configuration

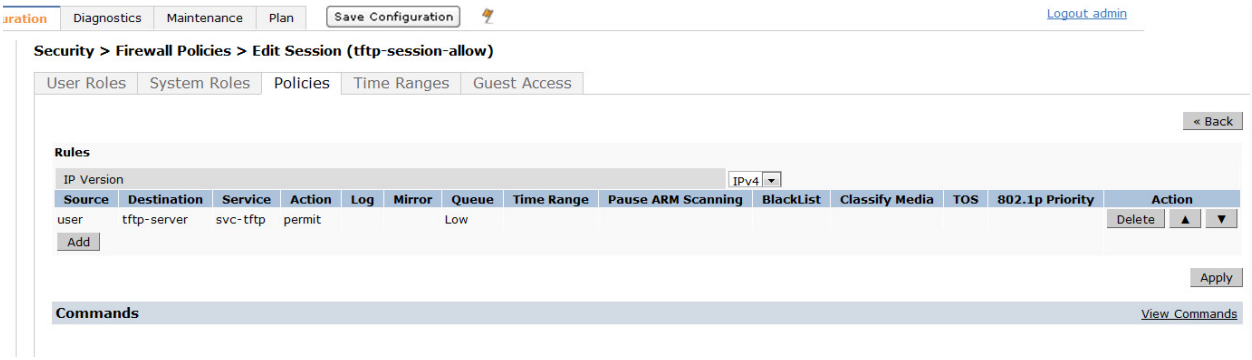
MC1-3600

```
!
ip access-list session tftp-session-allow
 user  alias tftp-server svc-tftp permit
!
```

WebUI Screenshot

MC1-3600

Figure 45 *tftp-session-allow policy*



Configuring the Application Role

To create the desired application role, you must order the essential firewall policies properly.

Table 17 summarizes the order of the policies in the application role that is used by the example network.

Table 17 *Policies in the Application Role*

Policy Number	Policy Name	Purpose
1	sip-session-allow	Allows SIP service. For details, see “Configuring the sip-session-allow Policy” on page 35.
2	dhcp-acl (predefined)	Allows DHCP service.
3	tftp-session-allow	Allows TFTP service. For details, see “Configuring the tftp-session-allow Policy” on the previous page.
4	dns-acl (predefined)	Allows DNS service.
5	icmp-acl (predefined)	Allows ICMP across the network.

CLI Configuration

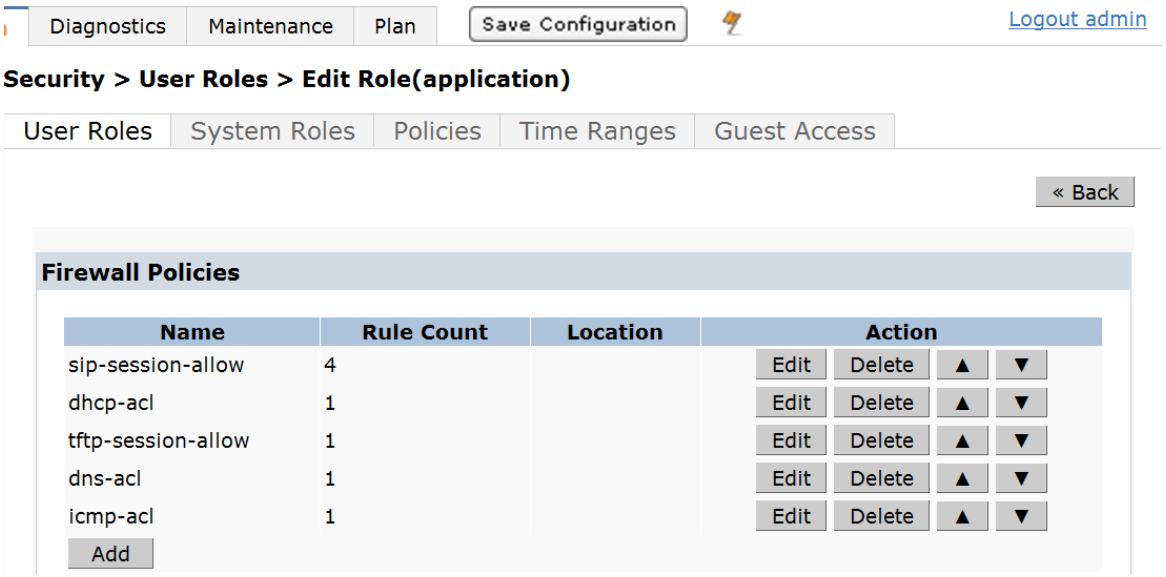
MC1-3600

```
!
user-role application
 access-list session sip-session-allow
 access-list session dhcp-acl
 access-list session tftp-Session-allow
 access-list session dns-acl
 access-list session icmp-acl
!
```

WebUI Screenshot

MC1-3600

Figure 46 *Application role*



Configuring the Application SSID Profile

The application SSID should be used strictly for devices that are not 802.1X capable. The application SSID uses WPA2-PSK for authentication and AES for encryption. PSKs are susceptible to social engineering attacks and offline dictionary attacks. The passphrase and key that is used should be at least 20 characters. To protect against social engineering attacks, the passphrase and key should not be distributed to everyone. Only the network administrators should know the passphrase.

In the example network, the WMM parameter is enabled to prioritize latency-sensitive applications, and the DSCP-to-WMM mapping values are set to defaults.

Table 18 summarizes the Corp-App SSID profile.

Table 18 *Corp-App SSID Profile*

SSID Profile	Network Name (SSID)	Authentication	Encryption	WMM	Purpose
Corp-App	Application	WPA2-PSK	AES	Enabled	Only for legacy devices that are not 802.1X capable.

CLI Configuration

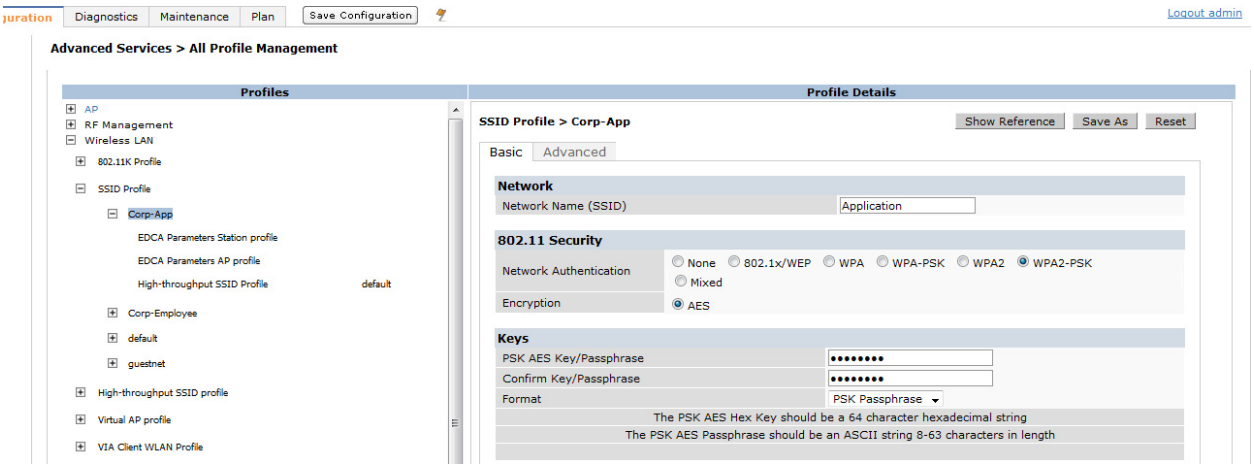
MC1-3600

```
!
wlan ssid-profile "Corp-App"
  essid "Application"
  opmode wpa2-psk-aes
  wmm
  wpa-passphrase **********
!
```

WebUI Screenshot

MC1-3600

Figure 47 *Corp-App SSID profile*



Configuring the Application AAA Profile

The AAA profile named corp-app is used for the application WLAN. PSK is used for authentication, so the default role that is assigned to authenticated users is specified in the initial role parameter of the AAA profile. To reduce the number of profiles, Dell has included the default-psk profile within the 802.1X profile. The profiles are combined because the dynamic key generation process of a WPA™/WPA2 PSK process is similar to that of 802.1X/EAP. The PSK passphrase is run through an algorithm that converts it into a pairwise master key (PMK). This PMK is used in the four-way handshake process to generate the dynamic encryption keys. Select the predefined profile named default-psk as the 802.1X profile when PSK is used for authentication.

The following parameters are configured in the corp-app AAA profile:

- Initial Role: application role (see "Configuring the Application Role" on page 50)
- 802.1X Profile: default-psk (predefined)

NOTE: If you do not assign an 802.1X profile in the AAA profile that is used for PSK, connectivity issues may occur.

CLI Configuration

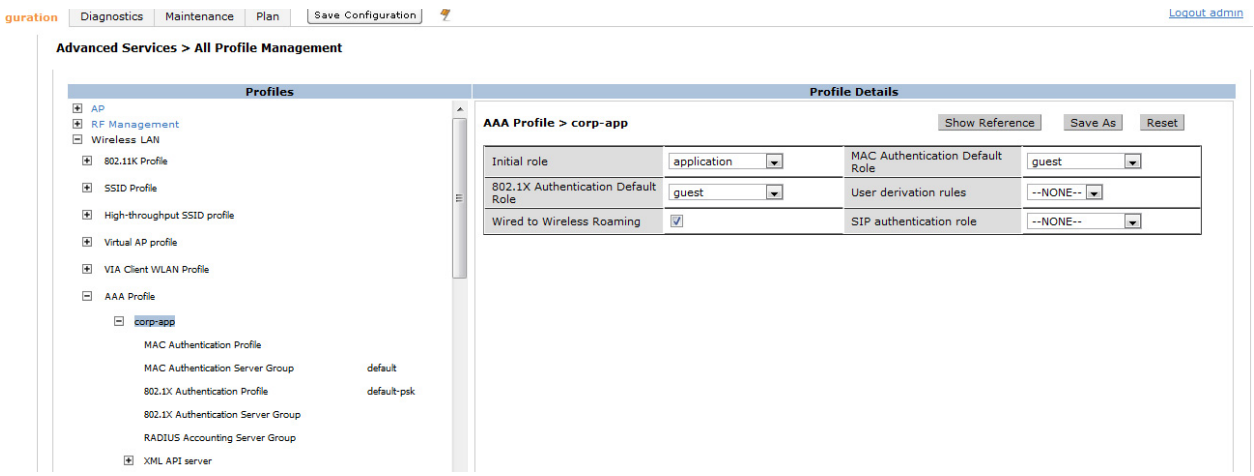
MC1-3600

```
!
aaa profile "corp-app"
  initial-role "application"
  authentication-dot1x "default-psk"
!
```

WebUI Screenshot

MC1-3600

Figure 48 *corp-app AAA profile*



Configuring the Application VAP Profiles

Figure 49 summarizes the application VAP profiles used in the example network.

Figure 49 *Application VAP profiles*

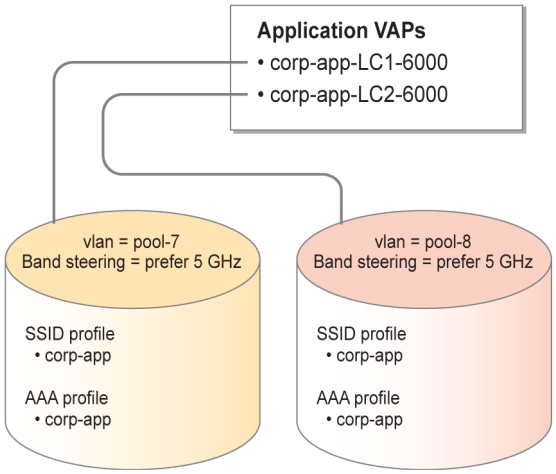


Table 19 lists the parameters that are configured for the Corp-App-LC1-6000 and Corp-APP-LC2-6000 VAP profiles.

Table 19 *Application VAP Profiles*

VAP Profile	VLAN	Band Steering	AAA Profile	SSID Profile
Corp-App-LC1-6000	pool-7	-Enabled -Prefer 5 GHz	corp-app	Corp-App
Corp-App-LC2-6000	pool-8	-Enabled -Prefer 5 GHz	corp-app	Corp-App

CLI Configuration

MC1-3600

```
!
```

```
wlan virtual-ap "Corp-App-LC1-6000"
  aaa-profile "corp-app"
  ssid-profile "Corp-App"
  vlan pool-7
  band-steering
  wmm-traffic-management-profile "corp-wmm"
!
wlan virtual-ap "Corp-App-LC2-6000"
  aaa-profile "corp-app"
  ssid-profile "Corp-App"
  vlan pool-8
  band-steering
  wmm-traffic-management-profile "corp-wmm"
!
```

WebUI Screenshot

MC1-3600

Figure 50 *Corp-App-LC1-6000 VAP profile*

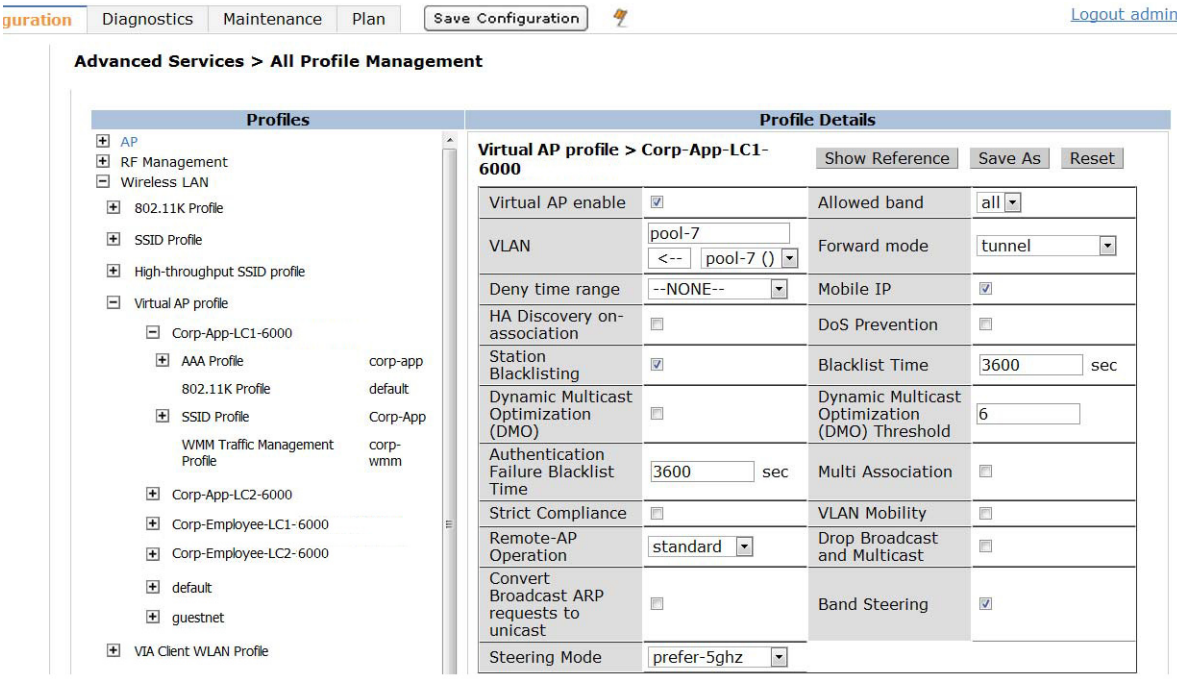
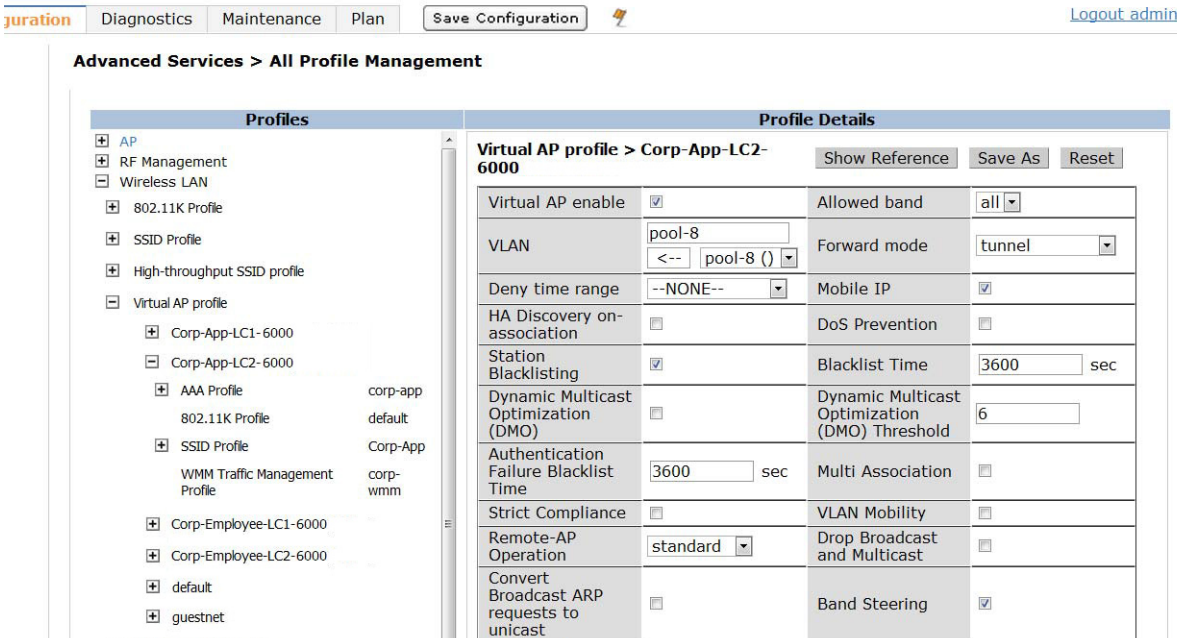


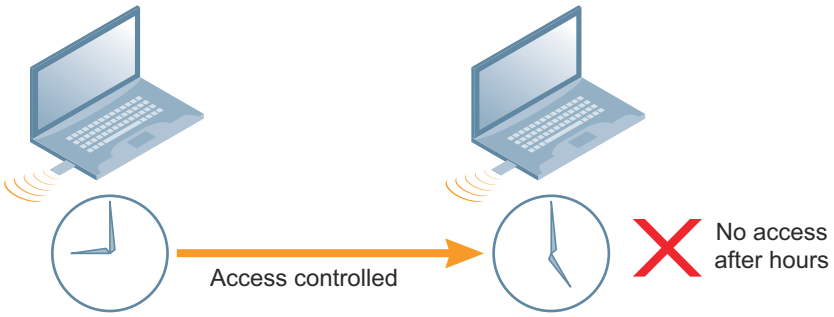
Figure 51 *Corp-App-LC2-6000 VAP profile*



Guest usage in enterprise wireless networks requires the following special consideration:

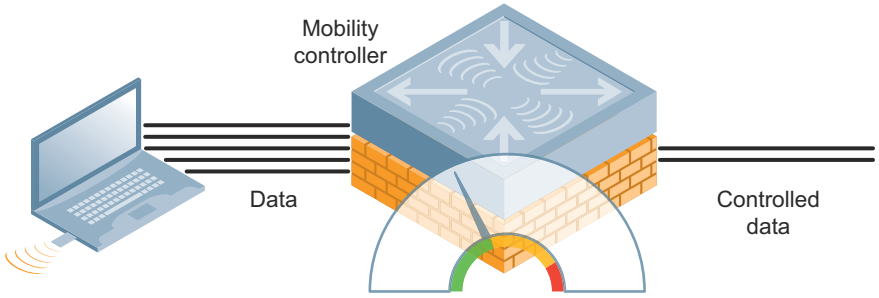
- Guest users must be separated from employee users by VLANs in the network.
- Guests must be limited not only in where they may go, but also by what network protocols and ports they may use to access resources.
- Guests should be allowed to access only the local resources that are required for IP connectivity. These resources include DHCP and possibly DNS if an outside DNS server is not available. In most cases, a public DNS is always available.
- All other internal resources should be off limits for the guest. This restriction is achieved usually by denying any internal address space to the guest user.
- A time-of-day restriction policy should be used to allow guests to access the network only during normal working hours, because they should be using the network only while conducting official business. Accounts should be set to expire when their local work is completed, typically at the end of each business day.

Figure 52 *Guest access has a time limit*



- A rate limit can be put on each guest user to keep the user from using up the limited wireless bandwidth. Employee users should always have first priority to the wireless medium for conducting company business. Remember to leave enough bandwidth to keep the system usable by guests. Dell recommends a minimum of 10% of total bandwidth be made available to guests. Guests can always burst when the medium is idle. For information about how to configure these bandwidth parameters, see "Traffic Management Profile" on page 83.

Figure 53 *Guest access has a bandwidth limit*



Unlike employees, the guest users typically log in through a captive portal. Usually, guests are assigned two different roles. One role is assigned when they associate to the guest SSID and the other is assigned when they authenticate

successfully through the captive portal. Only the guests who successfully authenticate are allowed to use the services needed to connect to the internet.

The example network uses the guest-logon role as the initial role and the auth-guest role for authenticated guests. Before you configure these two roles, first create the policies that are associated with them.

The guest-logon role uses these policies:

- ClearPass-GuestConnect
- captiveportal (predefined policy)
- guest-logon-access
- block-internal-access

The auth-guest role uses these policies:

- guest-logon-access
- block-internal-access
- auth-guest-access
- drop-and-log

Guest authentication and management can be provided through the internal resources of the Dell PowerConnect W-Series controller or through ClearPass GuestConnect. The internal resources of the Dell PowerConnect W-Series controller can be used for visitor management in small deployments. However, Dell recommends the use of ClearPass GuestConnect for visitor management in large campuses. For information on deploying the Dell PowerConnect W-Series controller for visitor management, see the *Dell PowerConnect W-Series ArubaOS 6.1 User Guide* available at support.dell.com/manuals. This VRD explains only the configurations required on the Dell controller when ClearPass GuestConnect is used for visitor management.

Configuring the ClearPass GuestConnect Policy

The ClearPass GuestConnect policy allows HTTP and HTTPS traffic only to the ClearPass GuestConnect server that is defined in the ClearPass GuestConnect alias. This policy used in the preauthenticated role allows the client-based HTTP and HTTPS traffic to reach the hosted captive portal pages on the ClearPass GuestConnect appliance.

Table 20 summarizes the rules used by the ClearPass GuestConnect policy.

Table 20 *Rules Used by the ClearPass GuestConnect Policy*

Rule Number	Source	Destination	Service	Time Range	Action	Purpose
1	User	Alias ClearPass-GuestConnect	Service svc-http	Working-hours	Scr-nat	This rule allows HTTP traffic from the users to ClearPass GuestConnect server. The permitted traffic is source-NATed.
2	User	Alias ClearPass-GuestConnect	Service svc-https	Working-hours	Scr-nat	This rule allows HTTPS traffic from the users to ClearPass GuestConnect server. The permitted traffic is source-NATed.

CLI Configuration

MC1-3600

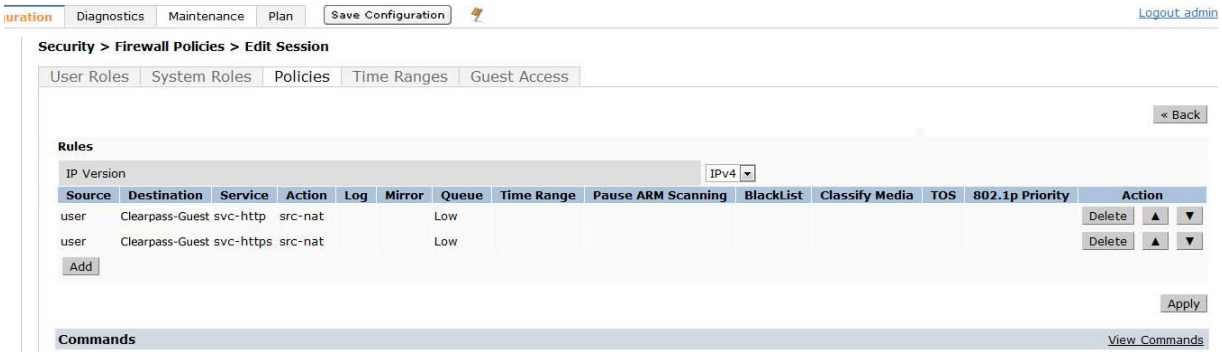
```
!
ip access-list session ClearPass-GuestConnect
  user   alias ClearPass-GuestConnect svc-http src-nat
```

```
    user    alias ClearPass-GuestConnect svc-https src-nat
!
```

WebUI Screenshot

MC1-3600

Figure 54 *ClearPass-GuestConnect policy*



Configuring the guest-logon-access Policy

The guest-logon-access policy is similar to the predefined logon-control policy, but it is much more restrictive. The guest-logon-access policy is a part of the guest-logon and auth-guest roles. The rules defined in this policy allow these exchanges:

- Allow DHCP exchanges between the user and the DHCP server during business hours, but block other users from responding to DHCP requests.
- Allow DNS exchanges between the user and the public DNS server during business hours. Traffic is source-NATed using the IP interface of the controller for the guest VLAN.

Guest users are denied access to the internal network, so the Public-DNS alias is used. All the DNS queries of the guest users are forwarded to these public DNS servers.

A time range is used to allow users to associate to the guest network only during certain hours of the day. A time range called Working-hours is created and used in the example network.

Table 21 summarizes the rules used by the guest-logon-access policy.

Table 21 *Rules Used by the guest-logon-access Policy*

Rule Number	Source	Destination	Service	Time Range	Action	Purpose
1	User	Any	UDP min port = 68 max port = 68		Drop	This rule drops responses from a personal DHCP server. This action prevents the clients from acting as DHCP servers. (This rule should be active always and not just during the working hours.)

Table 21 *Rules Used by the guest-logon-access Policy*

Rule Number	Source	Destination	Service	Time Range	Action	Purpose
2	Any	Any	Service svc-dhcp (udp 67 68)	Working-hours	Permit	This rule allows clients to request and discover DHCP IP addresses over the network. The DHCP server on the network does not fall under the user category. Therefore, its response on port 68 is not dropped by the first rule. The first two rules guarantee that DHCP is processed only by legitimate DHCP servers on the network.
3	Any	Alias Public-DNS	Service svc-dns (udp 53)	Working-hours	Scr-nat	This rule allows DNS queries only to the DNS servers that are defined in the Public-DNS alias. The allowed traffic is source-NATed.

CLI Configuration

MC1-3600

```
!
time-range "Working-hours" periodic Weekday 07:30 to 17:30
!
ip access-list session guest-logon-access
 user any udp 68 deny
 any any svc-dhcp permit time-range Working-hours
 user  alias Public-DNS svc-dns src-nat time-range Working-hours
!
```

WebUI Screenshot

MC1-3600

Figure 55 *Time range*

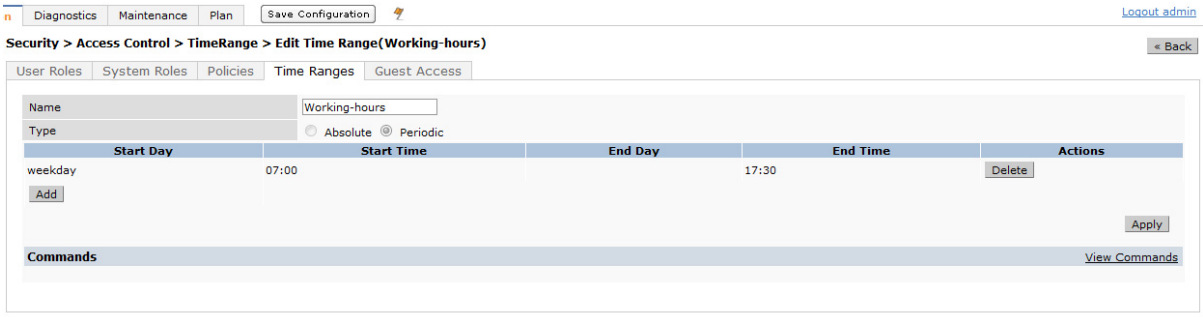
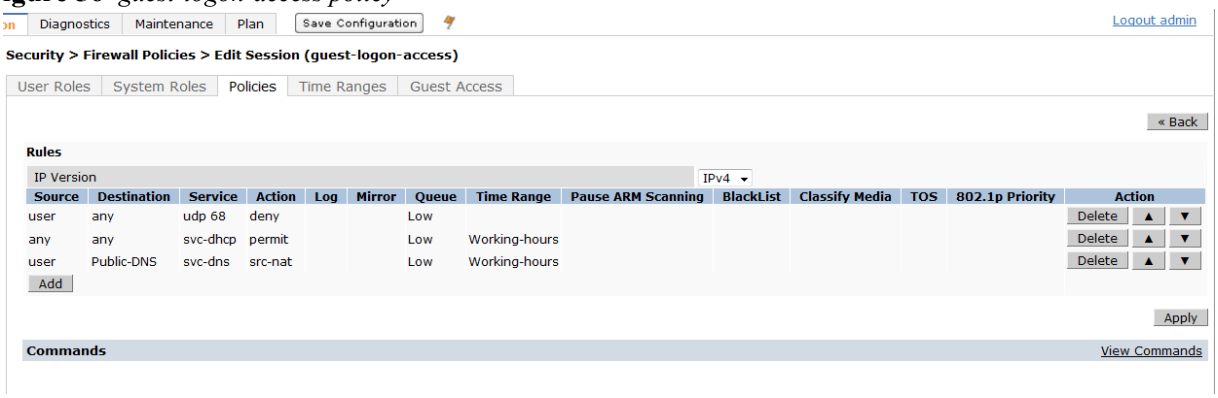


Figure 56 *guest-logon-access policy*



Configuring the block-internal-access Policy for the Guest Role

The internal resources of an organization should be available only to employees or to the trusted groups. Guest users are not part of the trusted entity, so they must be denied access to all internal resources. As the name implies, the block-internal-access policy denies access to all internal resources. This policy is a part of the guest-logon and auth-guest roles.

Table 22 summarizes the rule used by the block-internal-access policy.

Table 22 *Rule Used by the block-internal-access Policy*

Rule Number	Source	Destination	Service	Action	Purpose
1	User	Alias Internal-Network	Any	Drop	This rule denies access to all the addresses that are in the Internal- Network alias.

CLI Configuration

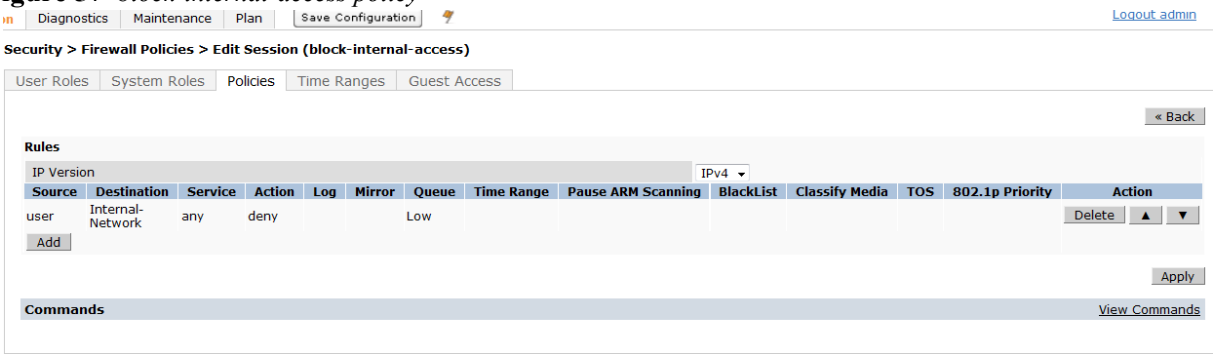
MC1-3600

```
!
ip access-list session block-internal-access
 user alias Internal-Network any deny
!
```

WebUI Screenshot

MC1-3600

Figure 57 *block-internal-access policy*



Configuring the auth-guest-access Policy

The most important purpose of the auth-guest-access policy is to define the protocols and ports that the users are allowed to access. This policy is an integral part of the auth-guest role. The auth-guest-access policy allows HTTP and HTTPS traffic to go to any destination from the user during business hours. The traffic is source-NATed using the IP interface of the controller for the guest VLAN.

Table 23 summarizes the rules used by the auth-guest-access policy.

Table 23 *Rules Used by the auth-guest-access Policy*

Rule Number	Source	Destination	Service	Time Range	Action	Purpose
1	User	Any	Service svc-http	Working-hours	Scr-nat	This rule allows HTTP traffic from the users to any destination. The permitted traffic is source-NATed.
2	User	Any	Service svc-https	Working-hours	Scr-nat	This rule allows HTTPS traffic from the users to any destination. The permitted traffic is source-NATed.

CLI Configuration

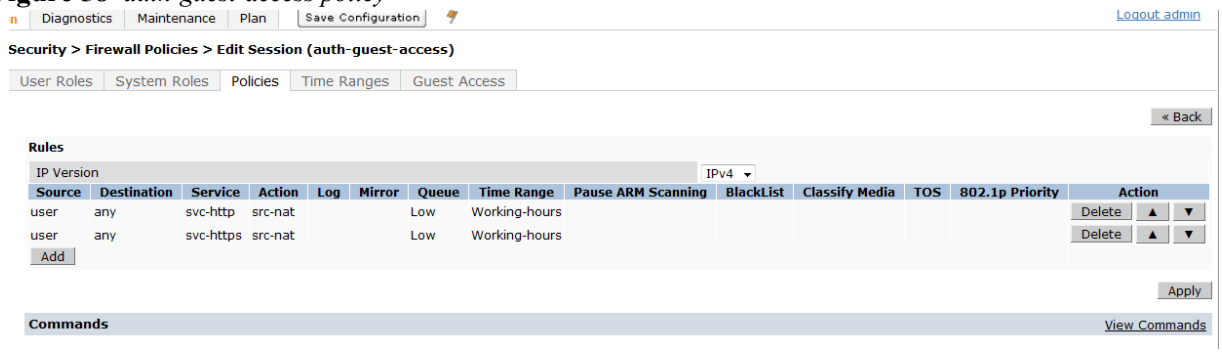
MC1-3600

```
!
ip access-list session auth-guest-access
 user any svc-http src-nat time-range Working-hours
 user any svc-https src-nat time-range Working-hours
!
```

WebUI Screenshot

MC1-3600

Figure 58 *auth-guest-access policy*



Configuring the drop-and-log Policy

The drop-and-log policy denies all traffic and records the network access attempt.

Table 24 summarizes the rule used by the drop-and-log policy.

Table 24 *Rule Used by the drop-and-log Policy*

Rule Number	Source	Destination	Service	Action	Log	Purpose
1	User	Any	Any	Deny	Yes	This rule denies access to all services on the network and logs the network access attempt.

CLI Configuration

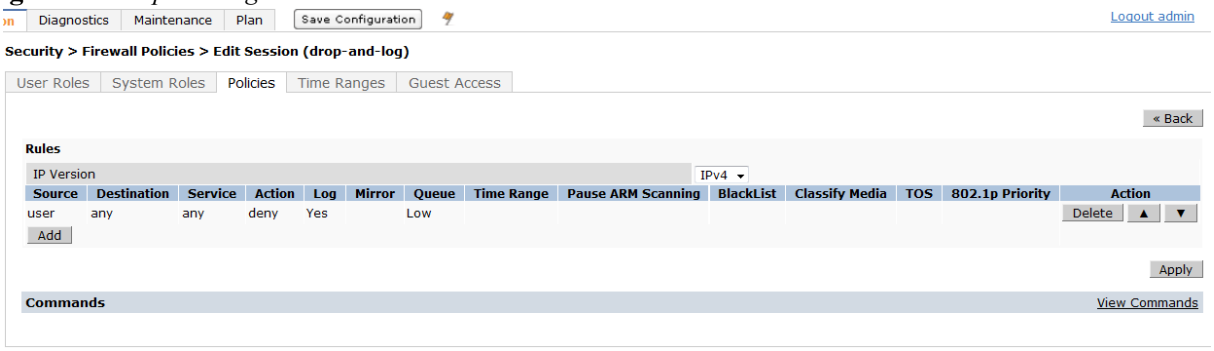
MC1-3600

```
!
ip access-list session drop-and-log
 user any any deny log
!
```

WebUI Screenshot

MC1-3600

Figure 59 *drop-and-log*



Configuring the Initial Guest Role

The guest-logon role is the first role that is assigned to the users when they associate with the guest SSID. A user in this role has access only to the DHCP and DNS services. Unlike 802.1X/EAP, captive portal is a Layer 3 type authentication. A user who associates to the guest SSID is given an IP address and related DNS information even before he authenticates himself. When this user opens the browser and tries to access a web page, the guest-logon role directs him to a captive portal page. The captive portal page requires login credentials. The captive portal authentication profile that is appended to this role specifies the captive portal login page and other configurable parameters, such as the default role, the authentication server, and the welcome page. To create and add the captive portal authentication profile to this initial guest role, see "Configuring the Captive Portal Authentication Profile for Guest WLAN" on page 69.

Table 25 summarizes the policies used in the guest-logon role.

Table 25 *Policies Used in the guest-logon Role*

Policy Number	Policy Name	Purpose
1	ClearPass-GuestConnect	Allows the client-based HTTP and HTTPS traffic to reach the hosted captive portal pages on the ClearPass GuestConnect appliance. If this policy is not used in the guest-logon role, the guest users cannot proceed to the login page on the ClearPass GuestConnect. The preauthenticated guest logon policy is usually designed to deny all traffic other than DHCP and DNS traffic. For details, see "Configuring the ClearPass GuestConnect Policy" on page 58.
2	captiveportal (predefined policy)	This predefined policy initiates captive portal authentication. This policy redirects any HTTP or HTTPS traffic to port 8080, 8081, or 8088 of the controller. When the controller sees traffic on these ports, it checks the captive portal authentication profile that is associated with the current role of the user and processes the values specified on this profile.
3	guest-logon-access	This policy allows DHCP and DNS services. For details, see "Configuring the guest-logon-access Policy" on page 59.
4	block-internal-access	This policy blocks access to the entire internal network. For details, see "Configuring the block-internal-access Policy for the Guest Role" on page 61.

CLI Configuration

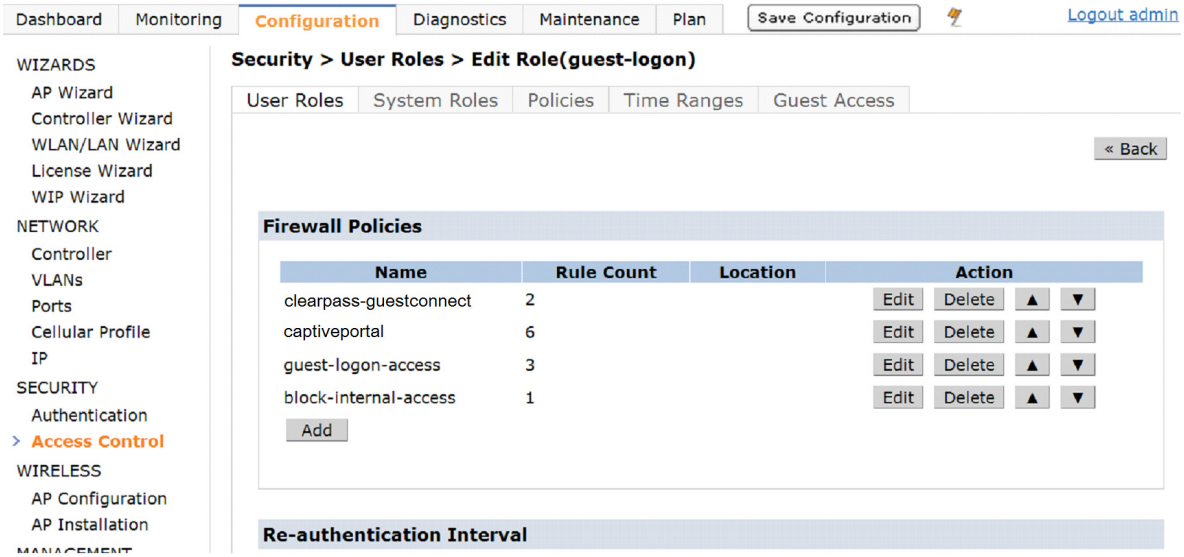
MC1-3600

```
!
user-role guest-logon
 access-list session ClearPass-GuestConnect
 access-list session captiveportal
 access-list session guest-logon-access
 access-list session block-internal-access
!
```

WebUI Screenshot

MC1-3600

Figure 60 *guest-logon role*



Configuring the Authenticated Guest Role

The auth-guest role is the role that is assigned to guest users after they authenticate successfully through the captive portal. This role is the default role in the captive portal authentication profile. In addition to restricting the network access to business hours, this role allows only HTTP and HTTPS services to access the Internet.

If an organization wants its guest users to use the printers in the internal network, a separate policy must be created that allows user traffic to an alias called printers. This alias must include only the IP address of the printers that the guests are allowed to use. Place this policy in the auth-guest user role just above the block-internal-access policy.

Table 26 summarizes the policies used in the auth-guest role.

Table 26 *Policies Used in the auth-guest Role*

Policy Number	Policy Name	Purpose
1	cplogout (predefined policy)	This policy makes the controller present captive portal logout window. If the user attempts to connect to the controller on the standard HTTPS port (443) the client will be NATed to port 8081, where the captive portal server will answer. If this rule is not present, a wireless client may be able to access the controller's administrative interface.

Table 26 *Policies Used in the auth-guest Role (Continued)*

Policy Number	Policy Name	Purpose
2	guest-logon-access	This policy denies personal DHCP servers and provides legitimate DHCP services and DNS.
3	block-internal-access	This policy blocks access to internal network. This policy should be placed before the next policy that allows HTTP and HTTPS service, otherwise guest users will have access to the internal websites.
4	auth-guest-access	This policy allows HTTP and HTTPS services to any destination.
5	drop-and-log	Any traffic that does not match the previous policies encounters this policy. This policy denies all services and logs the network access attempt.

CLI Configuration

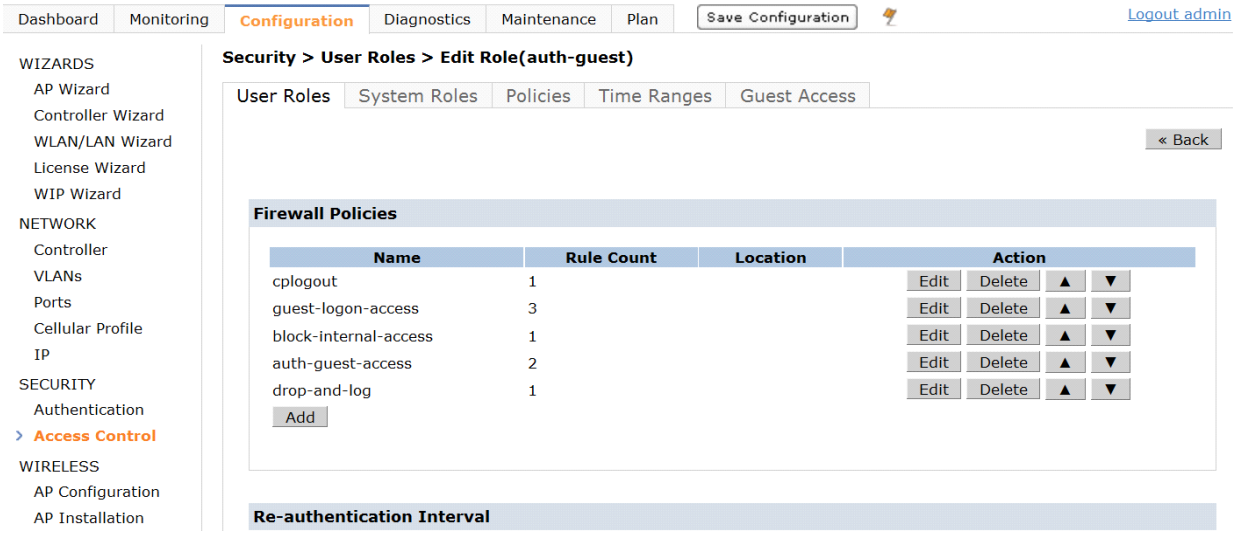
MC1-3600

```
!
user-role auth-guest
 max-sessions 65535
 access-list session cplogout
 access-list session guest-logon-access
 access-list session block-internal-access
 access-list session auth-guest-access
 access-list session drop-and-log
!
```

WebUI Screenshot

MC1-3600

Figure 61 *auth-guest*



Maximum User Sessions for Guest Role

Though it is a very small possibility, a malicious user can connect to the guest network and initiate a denial of service (DoS) attack by using up all of the 65535 sessions available. To defend against such an attack, restrict the maximum number of sessions per user in a role. Dell recommends that you restrict the maximum sessions per user in the guest role to 128. This limitation should be placed on all the roles used in the guest network.

The example network restricts the maximum sessions per user in the guest role to 128. This value is applied to the guest-logon and auth-guest roles.

CLI Configuration

MC1-3600

```
!
user-role guest-logon
  max-sessions 128
!
user-role auth-guest
 max-sessions 128
!
```

Configuring the Guest SSID Profile

The guest SSID does not provide any Layer 2 authentication and encryption. The Layer 2 authentication type used is open. In open authentication, hello messages are exchanged with the client before it is allowed to associate and obtain necessary IP information. All the user traffic is unencrypted. This WLAN uses captive portal to authenticate the users. The users that associate to this SSID are placed in the guest VLAN. Captive portal should never be used for employee authentication, because captive portal does not provide encryption. The wireless traffic is visible to anyone doing a passive packet capture unless the data is encrypted by higher-layer protocols such as HTTPS and IPsec.

Table 27 summarizes the guestnet SSID profile.

Table 27 *guestnet SSID Profile*

SSID Profile	Network Name (SSID)	Authentication	Encryption	WMM	Purpose
guestnet	Guest	Open	none	—	Guest users (Captive portal is a Layer 3 authentication type.)

CLI Configuration

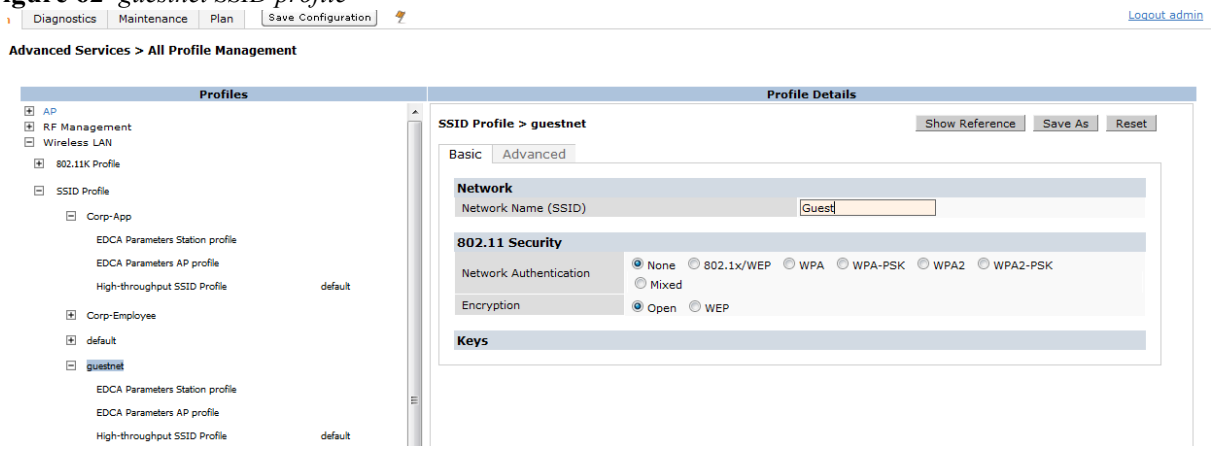
MC1-3600

```
!
wlan ssid-profile "guestnet"
  essid "Guest"
    opmode opensystem
!
```

WebUI Screenshot

MC1-3600

Figure 62 *guestnet SSID profile*



Configuring the Server Group for Guest Authentication

The core of ClearPass GuestConnect is a RADIUS server that uses the default ports of 1812 for authentication and 1813 for accounting. In the example network, a RADIUS server called ClearPass-GuestConnect is defined and added to a newly created server group called Guest-ClearPass-GuestConnect. The Guest-ClearPass-GuestConnect server group is used as the server group for captive portal authentication.

CLI Configuration

MC1-3600

```
!
aaa authentication-server radius "ClearPass-GuestConnect"
   host "10.169.130.50"
   key ***************
!
aaa server-group "Guest-ClearPass-GuestConnect"
```

```
 auth-server ClearPass-GuestConnect
!
```

WebUI Screenshot

MC1-3600

Figure 63 *ClearPass-GuestConnect RADIUS server*

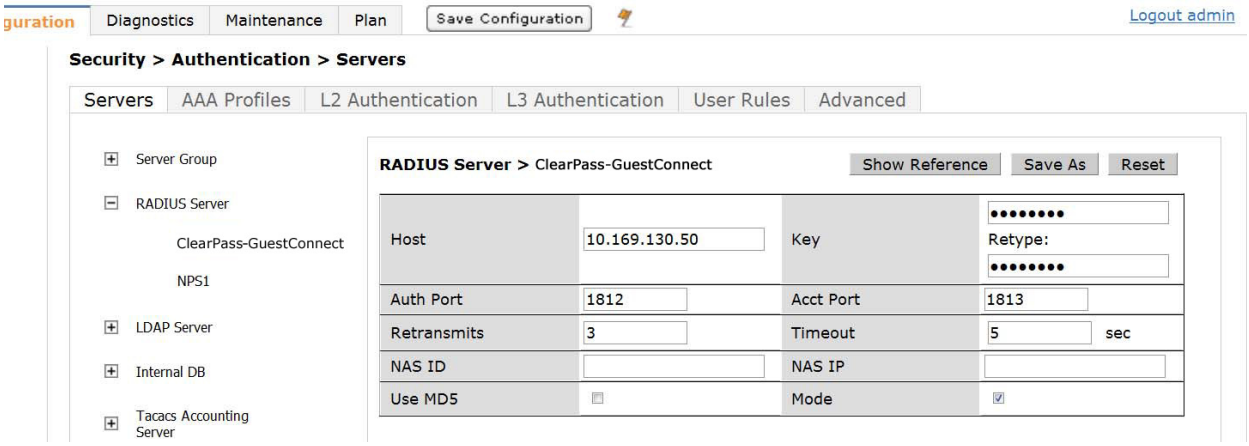
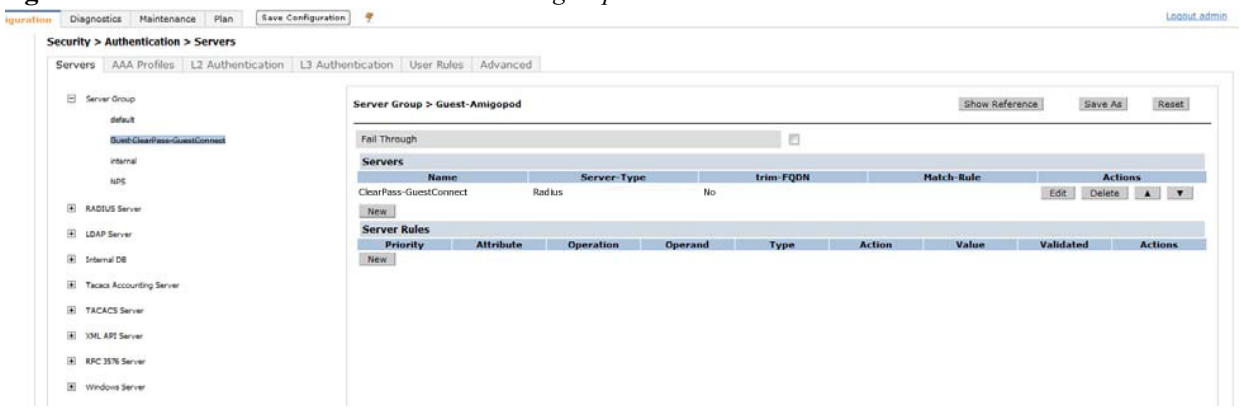


Figure 64 *Guest-ClearPass-GuestConnect server group*



Configuring the Captive Portal Authentication Profile for Guest WLAN

As discussed earlier, to authenticate the users associated with the guest SSID via captive portal, you must define and attach a captive portal profile to the initial role assigned to the guest users. Configurable parameters such as the default role, login page, welcome page, and others are available in a captive portal profile.

The following parameters are configured in the guestnet captive portal authentication profile used in the example network:

- The default role is *auth-guest*: This role is assigned to users after authentication (see "Configuring the Authenticated Guest Role" on page 65).
- Configure the login page: The value specified here is the URL to the login page hosted on the ClearPass GuestConnect server. In the example network, this value is set to https://10.169.130.50/Dell_login.php. When users in the initial guest role try to access internet through HTTP or HTTPS protocol, they are redirected to the login page specified in this field.
- Configure the welcome pages (optional): The value specified here can be the URL to the welcome page hosted on the ClearPass GuestConnect server, the default value, or any other external page (i.e. www.dell.com). In the

example network, this value is set to www.dell.com. The welcome page specified in this field is displayed after successful authentication.

- All other parameters use the default values.

CLI Configuration

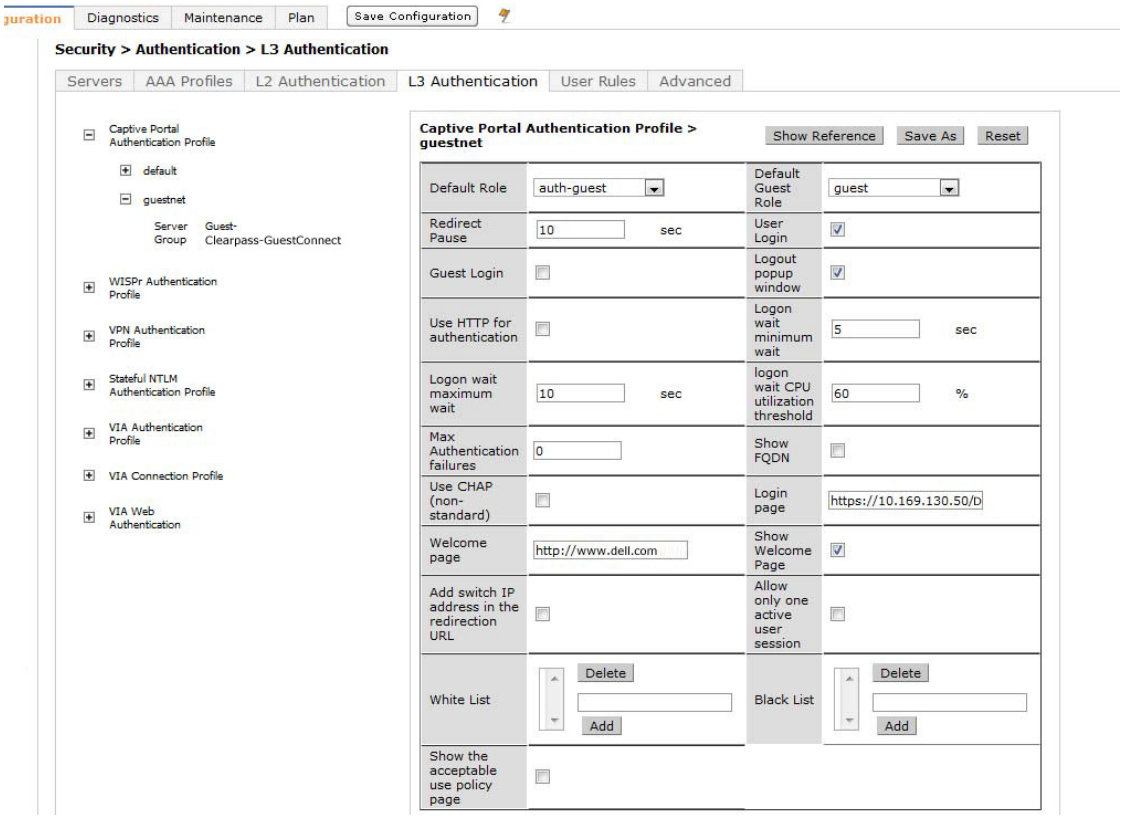
MC1-3600

```
!
aaa authentication captive-portal "guestnet"
   default-role "auth-guest"
   server-group "Guest-ClearPass-GuestConnect"
   login-page "https://10.169.130.50/Dell_login.php"
   welcome-page "http://www.dell.com"
!
```

WebUI Screenshot

MC1-3600

Figure 65 *guestnet captive portal profile*



After you have configured the captive portal profile, append it to the initial role, which is the guest-logon role in the example network.

CLI Configuration

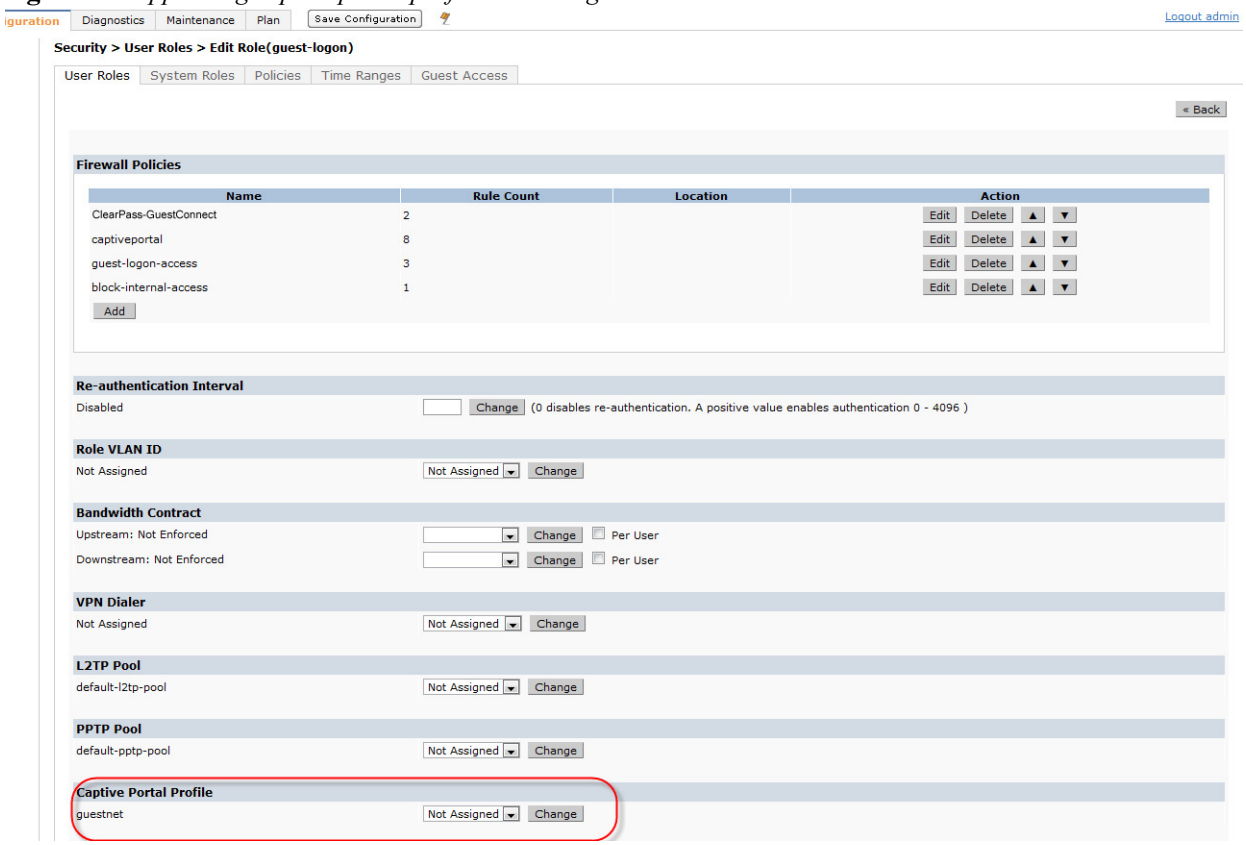
MC1-3600

```
!
user-role guest-logon
 captive-portal guestnet
!
```

WebUI Screenshot

MC1-3600

Figure 66 *Appending captive portal profile to initial guest role*



Configuring the Guest AAA Profile

Any user that accesses the network through the guest SSID is assigned the initial role specified in the guest AAA profile. The example network uses the guest-logon role as the initial role. This initial role is designed to allow DHCP and DNS, so the user gets an IP address. When the user opens up a browser, the user does a DNS lookup for his homepage. The guest-logon role permits DNS, so the homepage URL is resolved. When the user requests that page via HTTP/HTTPS, the captive portal ACL in the guest-logon role redirects that traffic to the controller on port 8080, 8081 or 8088. When the controller sees the traffic on one of these ports, it checks the current role of the user, which is the guest-logon role. The controller implements the parameters that are specified in the captive portal authentication profile that is tied to this role. After the user authenticates, the user is placed in an auth-guest role, which is the default role specified in the captive portal authentication profile.

The AAA profile named guestnet is used for the guest WLAN. In the guestnet AAA profile, configure the *guest-logon* role (see “Configuring the Initial Guest Role” on page 64) as the initial role.

CLI Configuration

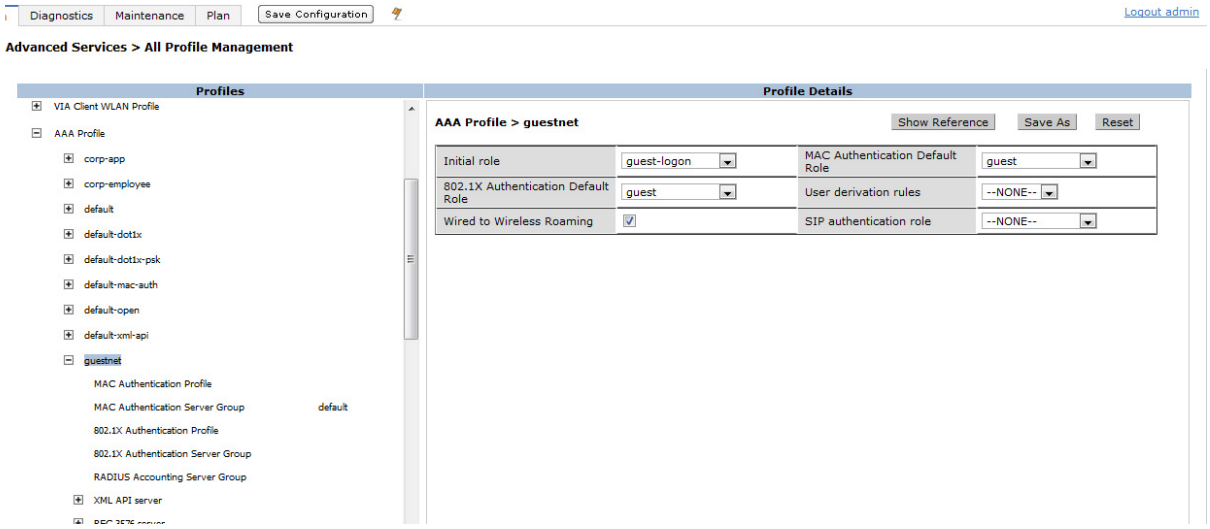
MC1-3600

```
!
aaa profile "guestnet"
  initial-role "guest-logon"
!
```

WebUI Screenshot

MC1-3600

Figure 67 *guestnet AAA profile*



Configuring the Guest VAP Profile

A guest VAP profile named “guestnet” is used in the example network. Figure 68 summarizes the guest VAP profile used in the example network.

Figure 68 *Guest VAP*

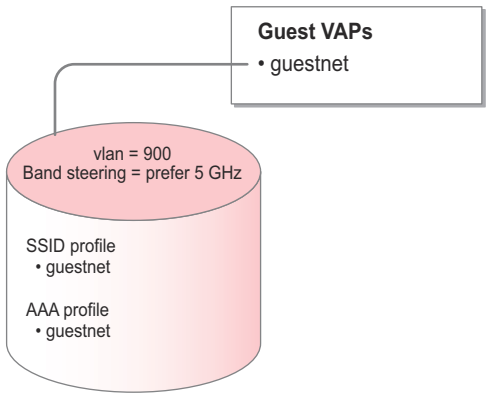


Table 28 lists the parameters that are configured for the guestnet VAP profile.

Table 28 *guestnet VAP Profile*

AAA Profile	SSID Profile	Band Steering	VLAN
guestnet	guestnet	-Enabled -Prefer 5 GHz	900

CLI Configuration

MC1-3600

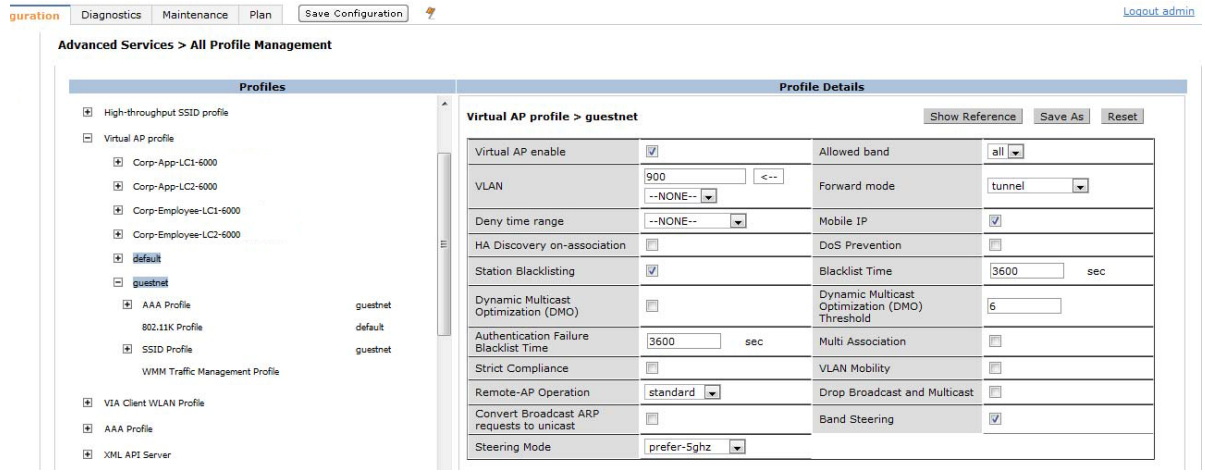
```
!
wlan virtual-ap "guestnet"
  aaa-profile "guestnet"
```

```
   ssid-profile "guestnet"
   vlan 900
   band-steering
!
```

WebUI Screenshot

MC1-3600

Figure 69 *guestnet VAP profile*



Chapter 12: Configuring the Radio Profiles

The 802.11a and 802.11g radio profiles form the core of RF management. The various profiles and options under RF management allow you to configure:

- radio tuning and calibration
- AP load balancing
- coverage hole detection
- received signal strength indicator (RSSI) metrics

Primarily, the 802.11a and 802.11g radio profiles determine the mode in which an AP radio operates. A radio can be made to operate in one of the following three predefined modes:

- ap-mode (for typical APs)
- am-mode (for AMs)
- spectrum-mode (for SMs)

The 802.11a and 802.11g profiles are independent of each other. So, a dual-radio AP can be configured to behave as an AM in one spectrum band and function as a regular AP in the other band. In addition to the basic radio settings, the 802.11a and 802.11g radio profiles within an AP group include these profiles:

- ARM profile (required only for client access APs)
- high-throughput radio profile
- spectrum profile (required only for dedicated SMs)
- AM scanning profile (required only for AMs)

Configuring the ARM Profile

The Adaptive Radio Management (ARM) feature is a set of tools that allow the WLAN infrastructure to make decisions about radio resources and client connections without manual intervention by network administrators or client-side software.

The ARM algorithms and services use the information that APs and AMs gather when they scan the RF environment. The infrastructure has a network-wide view of APs and clients, and this information is used to make adjustments to provide an optimal client experience.

The ARM feature provides the following functionalities:

- channel and power setting
- client-aware ARM
- voice-aware scanning
- video-aware scanning
- rogue-aware scanning
- load-aware scanning
- band steering
- spectrum load balancing

- mode-aware ARM
- adjusting receive sensitivity
- reducing rate adaptation
- dynamic multicast optimization (DMO)
- fair access
- local probe request threshold
- station handoff assist

The entire ARM feature set is not available in one place. Most features are configurable in the ARM profile. Band steering and DMO, which are defined per VAP, are available under VAP profiles. Fair access is in the traffic management profile. Spectrum load balancing and receive sensitivity options are defined within the 802.11a and 802.11g profiles. For detailed information on ARM, its features, and its advantages over traditional methods, see the *Dell PowerConnect W-Series 802.11n Networks Validated Reference Design*.

Table 29 summarizes the recommended ARM settings.

Table 29 *ARM Recommendation Matrix*

Feature	Sparse AP with Data Only	Dense AP with Data Only	When Enabling Video	When Enabling Voice
ARM Assignment	Single band (default) Multiband (for single-radio APs)	Single band (default) Multiband (for single-radio APs)	Single band (default) Multiband (for single-radio APs)	Single band (default) Multiband (for single-radio APs)
Client-Aware ARM	Enabled	Enabled	Enabled	Enabled
Voice-Aware Scanning	Enabled	Enabled	Enabled	Enabled
Video-Aware Scanning	Enabled	Enabled	Enabled	Enabled
Load-Aware Scanning	10 Mb/s (default)	10 Mb/s (default)	10 Mb/s (default)	10 Mb/s (default)
Power-Save-Aware Scanning	Disabled	Disabled	Disabled	Disabled
Rogue-Aware Scanning	Disabled except for high security environments	Disabled except for high security environments	Disabled except for high security environments	Disabled except for high security environments
Band Steering	Enabled, prefer 5 GHz (default)	Enabled, prefer 5 GHz (default)	Enabled, prefer 5 GHz (default)	Enabled, prefer 5 GHz (default)
Spectrum Load Balancing	Disabled	Enabled	Enabled	Disabled
Mode-Aware ARM	Disabled	Disabled	Disabled	Enable only to solve client issues
Adjusting Receive Sensitivity	Disabled	Disabled	Disabled	Disabled
Local Probe Request Threshold	Disabled	Enabled (value = 25 dB)	Enabled (value = 25 dB)	Enabled (value = 25 dB)
Station Handoff Assist	Disabled	Disabled	Disabled	Disabled
Intelligent Rate Adaptation	Always on, not configurable			

Table 29 *ARM Recommendation Matrix (Continued)*

Feature	Sparse AP with Data Only	Dense AP with Data Only	When Enabling Video	When Enabling Voice
Dynamic Multicast Optimization	Disabled	Disabled	Enabled – higher of 40 or 3 x number of VLANs	Disabled
Fair Access	Enabled	Enabled	Enabled	Enabled

Any deployment designed for coverage rather than capacity is considered as sprase. Network administrators should choose from the recommended settings mentioned in the table, depending on the traffic type and density of the deployment. For example, an organization that uses a separate AP group for lobby APs can use the spare deployment settings for all lobby APs and dense deployment settings for the others. Likewise, organizations with data, voice, and video on the network should follow the recommended settings for voice, but enable DMO to improve the efficiency for multicast video streaming.

The ARM profile is required only for APs that participate in ARM and not for the dedicated AMs or SMs. The scan-mode parameter in the ARM profile determines the scanning capabilities on an AP. This value can be set to:

- all-reg-domain: Scans all the channels in a spectrum band.
- reg-domain: Scans only the legal channels in a band. The legal channels in a band are determined by the local regulatory body.

The example network depicts a dense campus deployment with voice and data traffic. So, the example network uses the recommended settings for voice traffic for the ARM profile. The scan-mode is set as all-reg-domain.

CLI Configuration

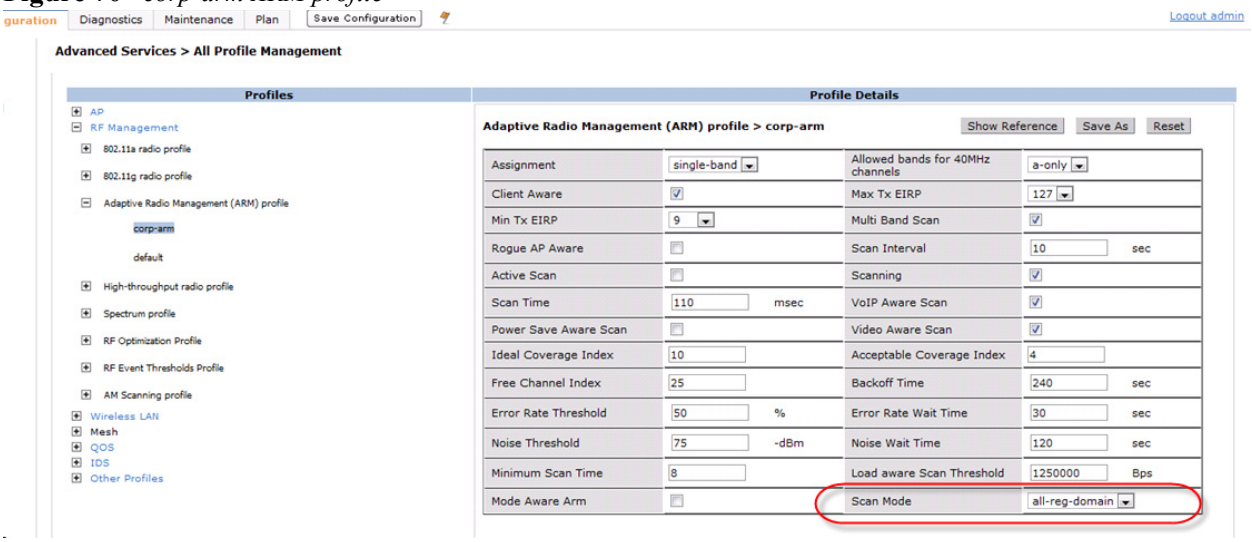
MC1-3600

```
!
rf arm-profile "corp-arm"
 voip-aware-scan
 no ps-aware-scan
 scan-mode all-reg-domain
!
```

WebUI Screenshot

MC1-3600

Figure 70 *corp-arm ARM profile*



Configuring the 802.11a and 802.11g Radio Profiles

The 802.11a and 802.11g radio profiles dictate the operation of the 5 GHz and 2.4 GHz radios respectively. Figure 71 summarizes the radio profiles used for the client access AP groups in the example network.

Figure 71 *Radio profiles of client access AP groups*

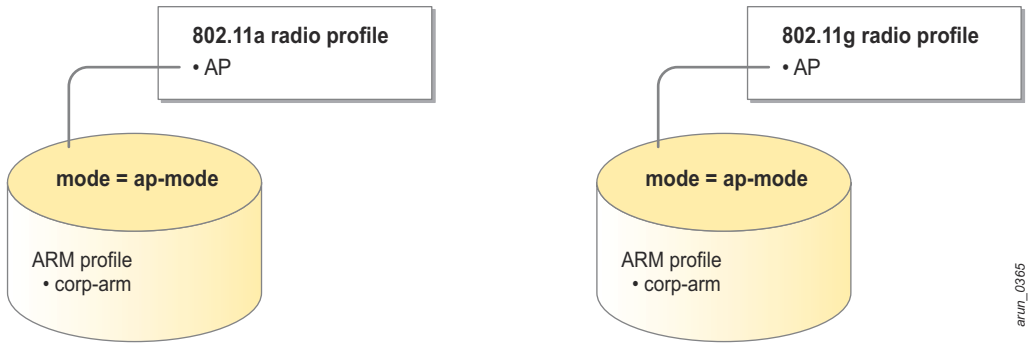


Table 30 summarizes the 802.11a and 802.11g radio profiles used in the example network by the AP groups built for client access.

Table 30 *Radio Profiles of Client Access AP Groups*

Profile Type	Profile Name	Mode	ARM Profile	AM Scanning profile	Purpose
802.11a radio Profile	AP	ap-mode	corp-arm	—	Makes the 5 GHz radio function as a typical AP.
802.11g radio Profile	AP	ap-mode	corp-arm	—	Makes the 2.4 GHz radio function as a typical AP.

CLI Configuration

MC1-3600

```
!
rf dot11a-radio-profile "AP"
   arm-profile "corp-arm"
!
rf dot11g-radio-profile "AP"
   arm-profile "corp-arm"
!
```

WebUI Screenshot

MC1-3600

Figure 72 *AP 802.11a radio profile*

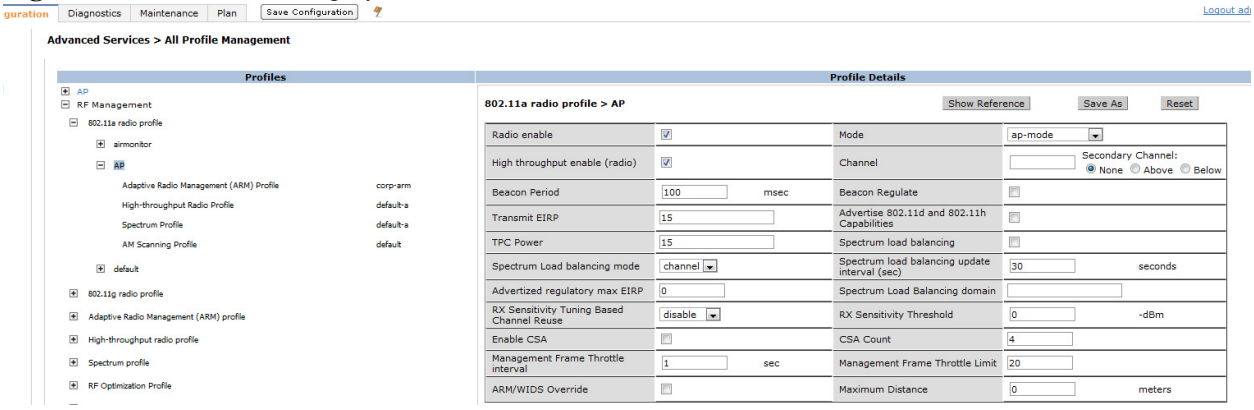
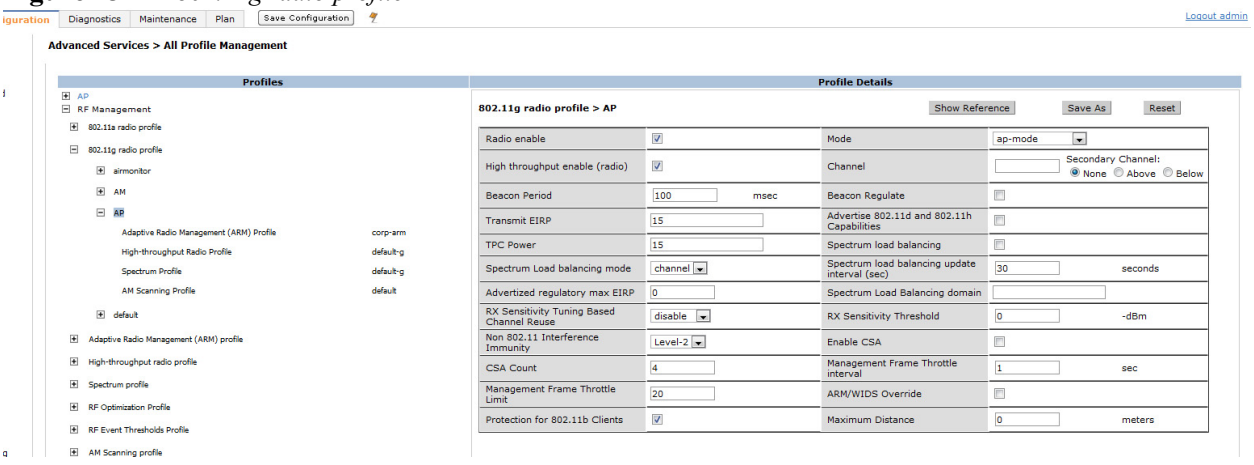


Figure 73 *AP 802.11g radio profile*



Chapter 13: Configuring the AP System Profiles

AP system profile defines these kinds of options:

- the LMS and backup LMS IP
- the real-time location services (RTLS) server values
- the number of consecutive missed heartbeats on a GRE tunnel before an AP bootstraps

In Dell PowerConnect W-Series terminology, the local management switch (LMS) is the controller that manages the AP and its traffic. In a typical deployment, when an AP boots up for the first time, it contacts the master controller. The master uses the lms-ip parameter to direct the AP to the mobility controller on which it should terminate its GRE tunnel. The lms-ip parameter is contained in the AP system profile of the AP group that is assigned to that AP. If defined, the backup LMS IP is used by the AP when the original controller becomes unreachable.

The example network does not use a backup LMS IP because the VRRP between the local controllers addresses the redundancy issue. For information about the advantages of VRRP and the use cases for backup LMS IP, see the *PowerConnect W-Series Mobility Controllers VRD*.

These two AP system profiles are used in the example network:

- LC1-6000
- LC2-6000

Only the lms-ip parameter is configured in both these AP system profiles in the master controller MC1-3600 of the example network. All other parameters are unaltered from their defaults.

Table 31 summarizes the AP system profiles used in the example network.

Table 31 *AP System Profiles*

Profile Name	LMS IP	Purpose
LC1-6000	10.169.145.7	This profile terminates the APs on LC1-6000 controller because it is the active controller for the VRRP-7 VIP 10.169.145.7. So if this controller fails, the VRRP makes the LC2-6000 controller the active controller for the VRRP-7, which eliminates the need to define a backup LMS IP.
LC2-6000	10.169.145.8	This profile terminates the APs on the LC2-6000 controller because it is the active controller for the VIP 10.169.145.8.

CLI Configuration

MC1-3600

```
!
ap system-profile "LC1-6000"
  lms-ip 10.169.145.7
!
ap system-profile "LC2-6000"
  lms-ip 10.169.145.8
!
```

WebUI Screenshot

MC1-3600

Figure 74 *LC1-6000 AP system profile*

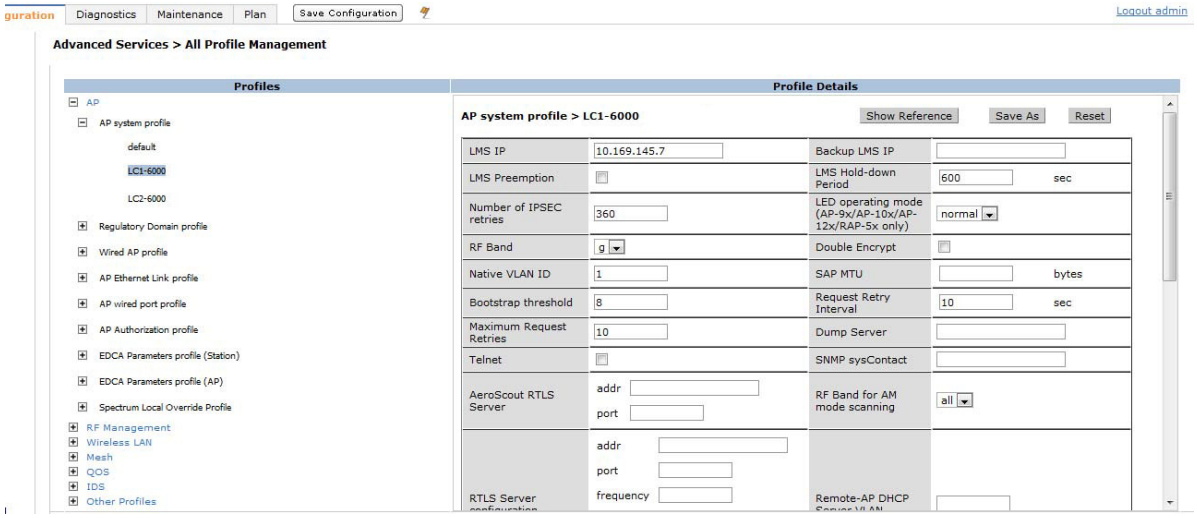
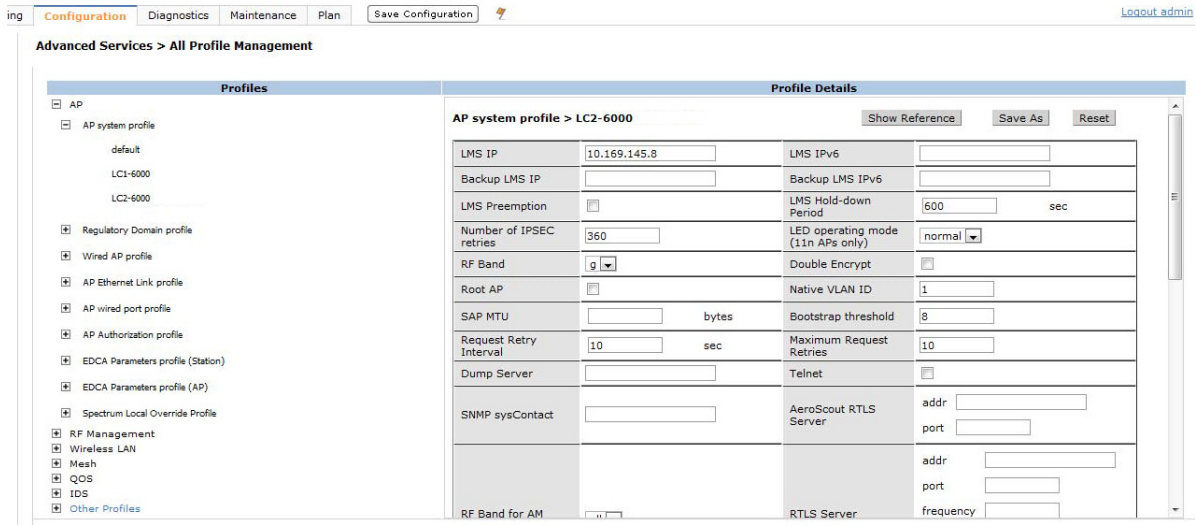


Figure 75 *LC2-6000 AP system profile*



Chapter 14: Configuring the QoS

The QoS profiles configure the traffic management and VoIP functions. The three main QoS profiles are these:

- WMM traffic management profile
- traffic management profile
- VoIP call admission control profile

Traffic Management Profile

The traffic management profile can be used to provide a service level agreement (SLA). The SLA guarantees a minimum percentage of available bandwidth to be allocated to a VAP when the wireless network is congested. The traffic management profile also defines the interval between bandwidth usage reports.

The traffic management profile is applied on a per radio basis, which means that an AP can have different traffic management profiles for the 802.11a radio and for the 802.11g radio. Traffic shaping must be set to fair-access to activate this bandwidth allocation value set for an individual VAP. When the traffic shaping feature is enabled, an AP tracks all active BSSIDs on a radio, all clients that are connected to the BSSID, and the 802.11a/g, 802.11b, or 802.11n capabilities of each client. During each sampling period, airtime is allocated to each client so that it can send and receive traffic.

Two traffic management profiles are used in the example network because the VAPs of the two client access AP groups are different. Table 32 summarizes the traffic management profiles that are used in the example network.

Table 32 *Traffic Management Profiles Used in Example Network*

Profile Name	Share per VAP	Station Shaping Policy	Usage
traffic-LC1-6000	45% (corp-employee-LC1-6000) 45% (corp-app-LC1-6000) 10% (guestnet)	fair-access	Used for AP group AP-LC1-6000.
traffic-LC2-6000	45% (corp-employee-LC2-6000) 45% (corp-app-LC2-6000) 10% (guestnet)	fair-access	Used for AP group AP-LC2-6000.

CLI Configuration

MC1-3600

```
!
wlan traffic-management-profile "traffic-LC1-6000"
  bw-alloc virtual-ap "Corp-App-LC1-6000" share 45
  bw-alloc virtual-ap "Corp-Employee-LC1-6000" share 45
  bw-alloc virtual-ap "guestnet" share 10
  shaping-policy fair-access
!
wlan traffic-management-profile "traffic-LC2-6000"
  bw-alloc virtual-ap "Corp-App-LC2-6000" share 45
  bw-alloc virtual-ap "Corp-Employee-LC2-6000" share 45
  bw-alloc virtual-ap "guestnet" share 10
  shaping-policy fair-access
!
```

WebUI Screenshot

MC1-3600

Figure 76 *traffic-LC1-6000 traffic management profile*

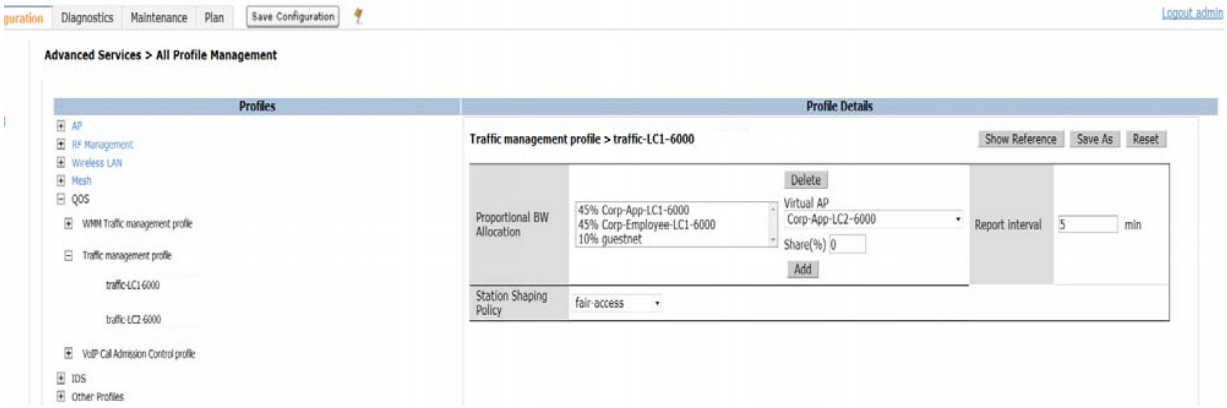
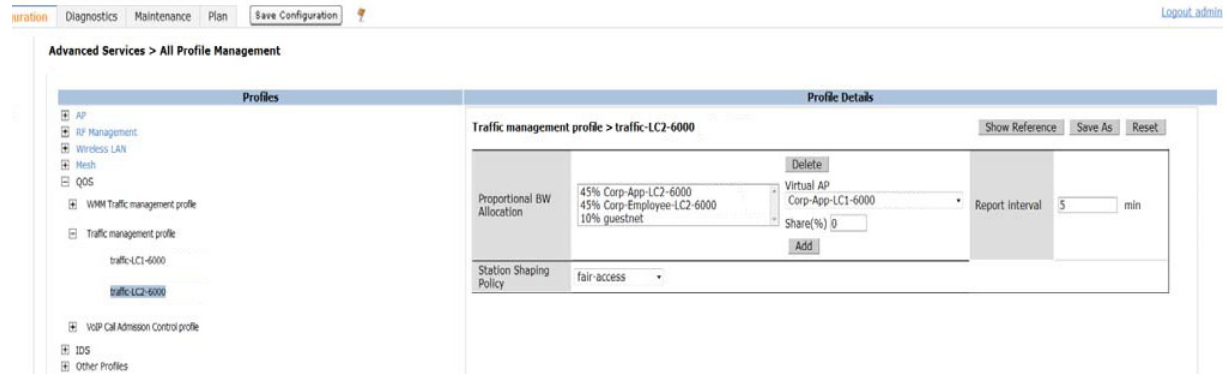


Figure 77 *traffic-LC2-6000 traffic management profile*



VoIP Call Admission Control Profile

Theoretically, based on a pure bandwidth perspective, an 802.11n AP can support hundreds of simultaneous voice calls. But in practice, the limiting factor is contention for the wireless medium. The 802.11 technology uses a collision-avoidance algorithm that makes timely access to the wireless media a challenge for delay-sensitive devices. Even with prioritization enabled for voice traffic, as the number of simultaneous voice clients increases, the

contention increases, which delays the access to the wireless medium. Due to this limitation, the number of simultaneous voice calls that a single AP must process must be limited. VoIP call admission control (CAC) lets the Dell controller limit the number of voice calls on an AP and proactively move voice clients to a less-utilized AP. Dell controllers implement CAC by statefully following voice protocols and being aware of the voice utilization of a given AP. In a mixed-client environment, Dell recommends that you limit the number of simultaneous active voice calls to 12 and reserve 25% of this call limit for roaming clients on an active call. In a pure 802.11n environment where all the voice clients are 802.11n-capable, this value can be increased to 18-20 clients with 25% reserved for roaming clients.

The example network has 802.11a/b/g and n clients, so the VoIP CAC profile that is used in the example network limits the number of active voice calls to 12.

Table 33 summarizes the VoIP CAC profile that is used by the example network.

Table 33 *VoIP Call Admission Control Profile Used in Example Network*

Profile Name	VoIP Call Admission Control	VoIP Call Capacity	VoIP Call Handoff Reservation
corp-voip-cac	Enabled	12	25%

CLI Configuration

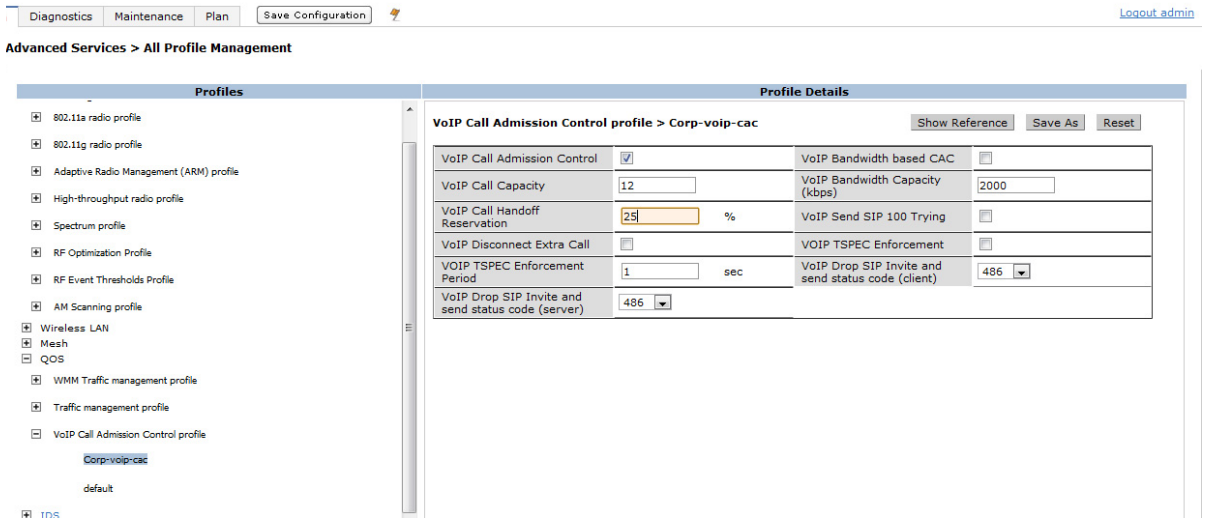
MC1-3600

```
!
wlan voip-cac-profile <corp-voip-cac>
call-admission-control
call-capacity 12
call-handoff-reservation 25
!
```

WebUI Screenshot

MC1-3600

Figure 78 *corp-voip-cac VoIP call admission control profile*



Chapter 15: Configuring the Client Access AP Groups

An AP group is a unique collection of configuration profiles. After you have configured all the required profiles, it is easy to form an AP group. To form an AP group, simply mix-and-match profiles based on the requirements.

The AP-LC1-6000 AP group is used for all APs that must be managed by the LC1-6000 local controller. The AP-LC2-6000 AP group is used for all APs that must be managed by the LC2-6000 local controller.

Table 34 summarizes the two AP groups that are used to provide client access in the example network and the profiles associated with each of these AP groups.

Table 34 *AP-LC1-6000 and AP-LC2-6000 AP Groups*

Profile Categories	Profile Type	AP-LC1-6000 Profiles Used	AP-LC2-6000 Profiles Used
Wireless LAN	VAP profile	corp-employee-LC1-6000 corp-app-LC1-6000 guestnet	corp-employee-LC2-6000 corp-app-LC2-6000 guestnet
RF Management	802.11a radio profile	AP	AP
	802.11g radio profile	AP	AP
AP	AP system profile	LC1-6000	LC2-6000
QoS	802.11a traffic management profile	traffic-LC1-6000	traffic-LC2-6000
	802.11g traffic management profile	traffic-LC1-6000	traffic-LC2-6000
	VoIP call admission control profile	corp-voip-cac	corp-voip-cac
IDS	IDS profile (use the wizard)	Corp-WIPS (Created using the wizard, see , “Chapter 18: Wireless Intrusion Prevention (IDS Profiles) of RFProtect” on page 99.)	Corp-WIPS (Created using the wizard, see , “Chapter 18: Wireless Intrusion Prevention (IDS Profiles) of RFProtect” on page 99.)

CLI Configuration

MC1-3600

```
!
ap-group "AP-LC1-6000"
  virtual-ap "guestnet"
  virtual-ap "corp-app-LC1-6000"
  virtual-ap "corp-employee-LC1-6000"
  dot11a-radio-profile "AP"
  dot11g-radio-profile "AP"
  ap-system-profile "LC1-6000"
  voip-cac-profile "Corp-voip-cac"
  dot11a-traffic-mgmt-profile "traffic-LC1-6000"
  dot11g-traffic-mgmt-profile "traffic-LC1-6000"
  ids-profile " Corp-WIPS "
!
ap-group "AP-LC2-6000"
  virtual-ap "guestnet"
  virtual-ap "corp-app-LC2-6000"
  virtual-ap "corp-employee-LC2-6000"
  dot11a-radio-profile "AP"
  dot11g-radio-profile "AP"
  ap-system-profile "LC2-6000"
  voip-cac-profile "corp-voip-cac"
  dot11a-traffic-mgmt-profile "traffic-LC2-6000"
  dot11g-traffic-mgmt-profile "traffic-LC2-6000"
  ids-profile " Corp-WIPS "
!
```

WebUI Screenshot

MC1-3600

Figure 79 *AP-LC1-6000 AP group*

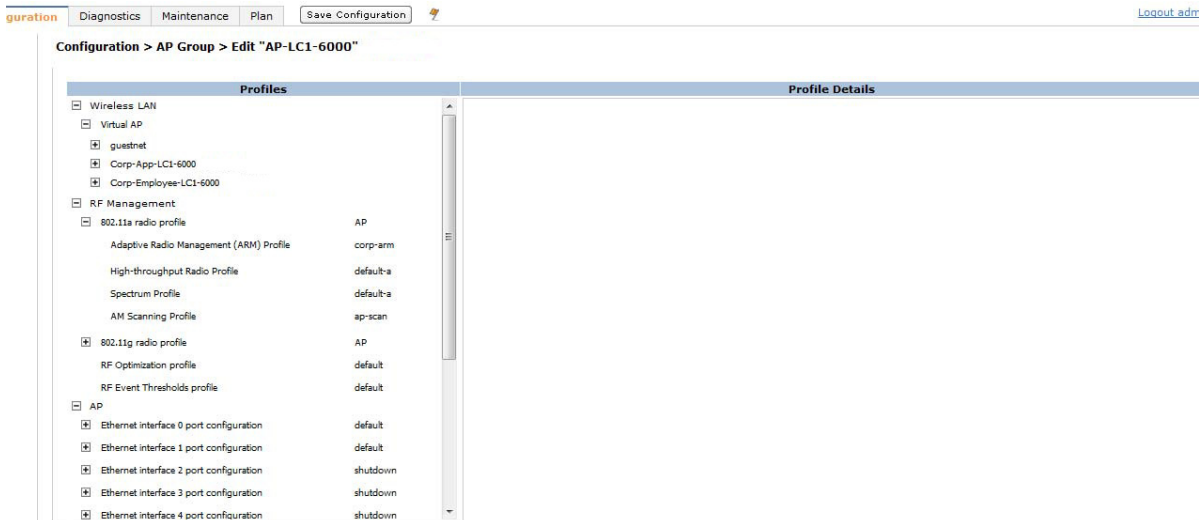
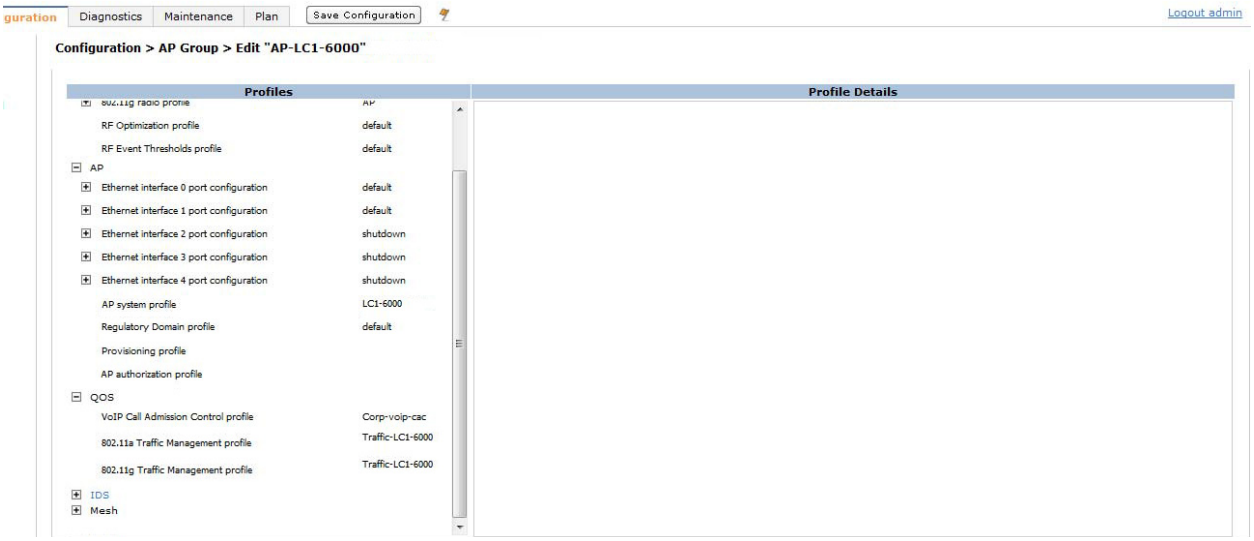


Figure 80 *AP-LC1-6000 AP group*



Chapter 16: AP Groups for Air Monitors

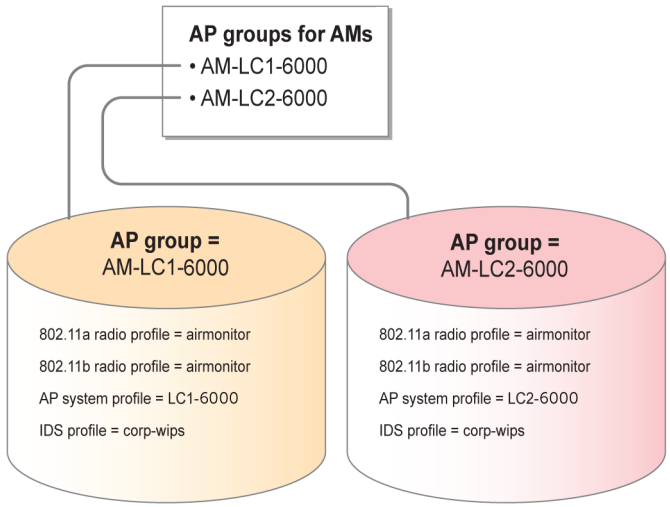
The air monitor (AM) does not provide service to any clients, so VAP profiles and traffic management profiles are not used by AP groups that are built for AMs. To create an AP group for AMs, you need these profiles:

- AM scanning profile
- 802.11a radio profile
- 802.11g radio profile
- AP system profile
- IDS profile

In the example network, the AM-LC1-6000 AP group is designed to terminate the AMs on VRRP-7 VIP. The AM-LC2-6000 AP group terminates the AMs on VRRP-8 VIP.

Figure 81 summarizes the AP groups used for AMs in the example network.

Figure 81 *AP groups for AMs*



Configuring the AM Scanning Profile

The RFProtect feature set that was introduced in the Dell PowerConnect W-Series ArubaOS 6.0 provides the TotalWatch™ scanning tool. When you add the RFProtect license, TotalWatch is enabled by default. TotalWatch extends the scanning capabilities of an AM to all the 14 channels in the 2.4 GHz and to the entire 4.9 – 5.895 GHz spectrum in 5 MHz increments.

△ **CAUTION: Only rogues on legal channels are contained wirelessly, but rogues on any channel can be contained using wired containment. All rogues that are detected wirelessly are reported, but wireless containment can be taken only against rogues that operate within the regulatory domain. APs and AMs cannot transmit, even to contain rogues, outside of the legal regulatory domain channels they are operating in without violating local law. The 4.9 GHz range is reserved for public safety applications in most regulatory domains. The open source hardware drivers and software-defined radios in many consumer grade APs mean that a malicious user could program an AP to operate illegally in this range. Dell AMs scan this range and report back any rogue AP found operating on this band. However, due to regulatory restrictions, the AM cannot contain the device.**

For more information about TotalWatch, see the *Dell PowerConnect W-Series Mobility Controllers Validated Reference Design.*

The AM scanning profile defines all the settings that are related to TotalWatch. The scanning profile applies only to radios operating as dedicated AMs and determines their scanning capabilities. The scanning capabilities of a radio operating as an AP are determined by the scan-mode parameter in the ARM profile. Dell does not recommend that you change the following four parameters of this profile under any circumstances:

- Dwell time: active channels
- Dwell time: regulatory domain channels
- Dwell time: non-regulatory domain channels
- Dwell time: rare channels

The scan-mode parameter in this profile determines the range of channels that are scanned by an AM. Dell recommends that you set this value to rare for all AMs. If you set this value to rare on AMs, the AMs scan the 4.9 GHz range and the entire 2.4 GHz and 5 GHz range.

The example network uses the AM scanning profile named am-scan for the AMs. Table 35 summarizes the AM scanning profile that is used.

Table 35 *AM Scanning Profile Used in Example Network*

AM Scanning Profile Name	Scan Mode	Purpose
am-scan	rare	Used for all AMs. Scans all the 14 channels in the 2.4 GHz and the entire 4.9 – 5.895 GHz spectrum in 5 MHz increments.

CLI Configuration

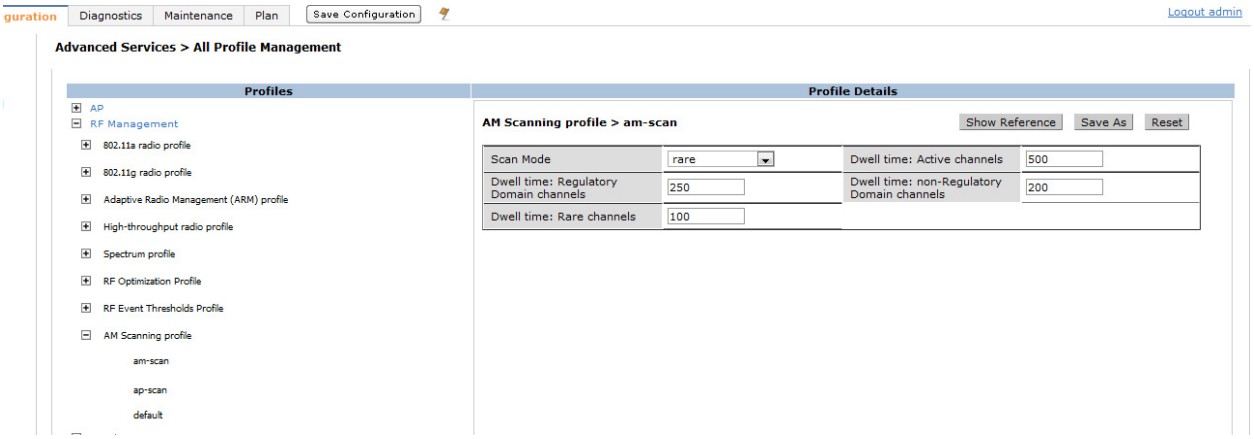
MC1-3600

```
!
rf am-scan-profile "am-scan"
  scan-mode rare
!
```

WebUI Screenshot

MC1-3600

Figure 82 *am-scan AM scanning profile*



Configuring the 802.11a and 802.11g Radio Profiles

For AMs, the mode parameter in the 802.11a and 802.11g radio profiles is set to am-mode. Figure 83 summarizes the radio profiles used in the example network for air monitor AP groups.

Figure 83 *Radio profiles for air monitor AP groups*

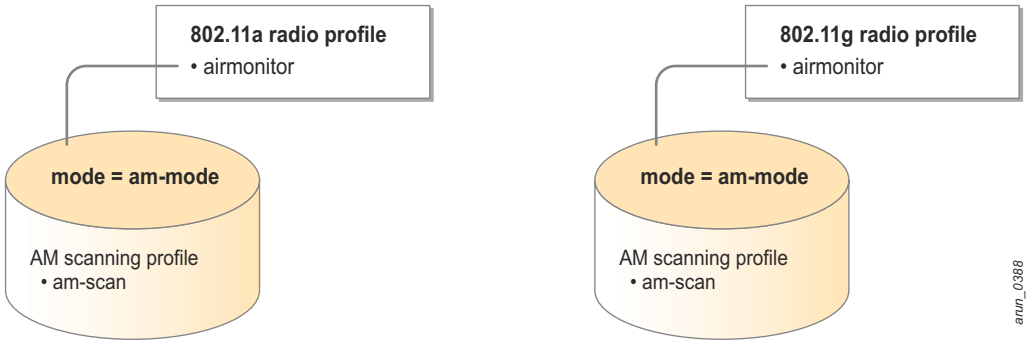


Table 36 summarizes the 802.11a and 802.11g radio profiles used in the example network by the AP groups built for AMs.

Table 36 *Radio Profiles of AP Groups Used for AMs*

Profile Type	Profile Name	Mode	ARM Profile	AM Scanning Profile	Purpose
802.11a radio profile	airmonitor	am-mode	—	am-scan	Makes the 5 GHz radio function as an AM
802.11g radio profile	airmonitor	am-mode	—	am-scan	Makes the 2.4 GHz radio function as an AM

CLI Configuration

MC1-3600

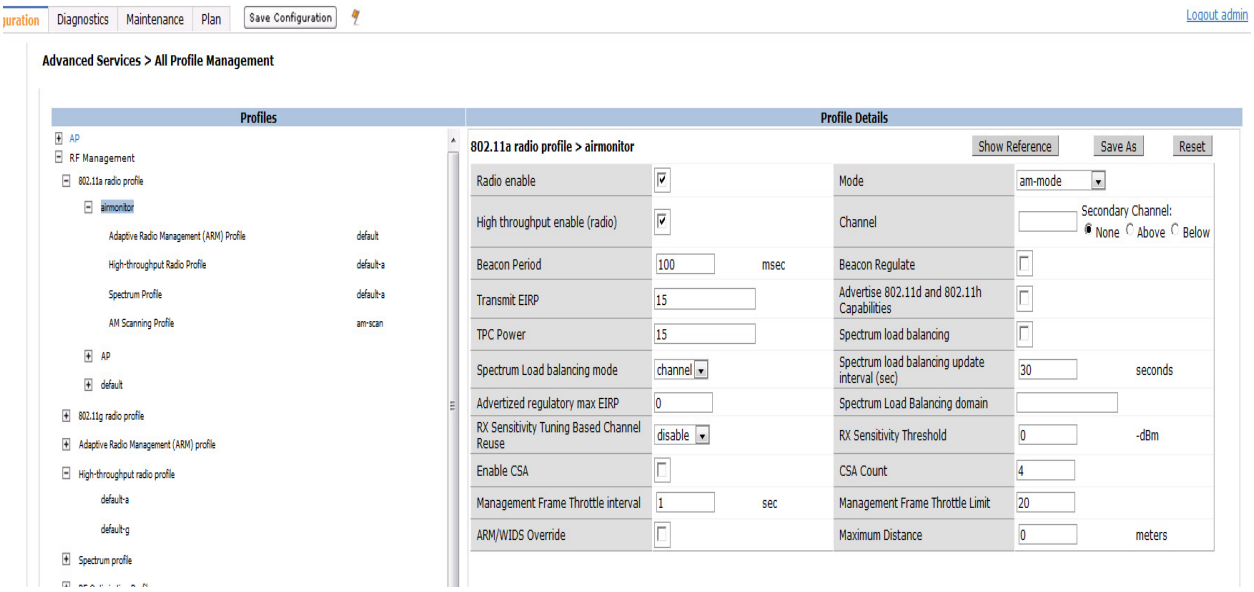
```
!
rf dot11a-radio-profile "airmonitor"
```

```
   mode am-mode
   am-scan-profile "am-scan"
!
rf dot11g-radio-profile "airmonitor"
   mode am-mode
   am-scan-profile "am-scan"
!
```

WebUI Screenshot

MC1-3600

Figure 84 *airmonitor 802.11a radio profile*



Configuring the AP Groups for Air Monitors

The AMs in AM-LC1-6000 AP group terminate on the LC1-6000 local controller and the AMs in AM-LC2-6000 AP group terminate on the LC2-6000 local controller.

Table 37 summarizes the two AP groups used for AMs on the example network and the profiles associated with each of these AP groups.

Table 37 *AM-LC1-6000 and AM-LC2-6000 AP Groups*

Profile Categories	Profile Type	AP-LC1-6000 Profiles Used	AP-LC2-6000 Profiles Used
Wireless LAN	VAP profile	—	—
RF Management	802.11a radio profile	airmonitor	airmonitor
	802.11g radio profile	airmonitor	airmonitor
AP	AP system profile	LC1-6000. For details, see , “Configuring the AP System Profiles” on page 101.	LC2-6000. For details, see , “Configuring the AP System Profiles” on page 101

Table 37 *AM-LC1-6000 and AM-LC2-6000 AP Groups*

Profile Categories	Profile Type	AP-LC1-6000 Profiles Used	AP-LC2-6000 Profiles Used
QoS	802.11a traffic management profile	—	—
	802.11g traffic management profile	—	—
	VoIP call admission control profile	—	—
IDS	IDS profile (use the wizard)	Corp-WIPS (Created using the wizard, see , "Wireless Intrusion Prevention (IDS Profiles) of RFProtect" on page 121.)	Corp-WIPS (Created using the wizard, see , "Wireless Intrusion Prevention (IDS Profiles) of RFProtect" on page 121.)

CLI Configuration

MC1-3600

```
!
ap-group "AM-LC1-6000"
  dot11a-radio-profile "airmonitor"
  dot11g-radio-profile "airmonitor"
  ap-system-profile "LC1-6000"
  ids-profile "Corp-WIPS"
!
ap-group "AM-LC2-6000"
  dot11a-radio-profile "airmonitor"
  dot11g-radio-profile "airmonitor"
  ap-system-profile "LC2-6000"
  ids-profile " Corp-WIPS"
!
```

Chapter 17: Altering the Default AP Group for Pre 6.1 ArubaOS

The Dell controllers running earlier versions of ArubaOS have a predefined AP group named default. When an AP boots up and finds a controller, it is automatically placed in the default AP group. This AP group has a default VAP and SSID that have open authentication by default. The AP now broadcasts the default SSID to which clients can connect. Dell recommends that network administrators change the following defaults:

- default ap-group
- default virtual-ap
- default ssid

Dell recommends that network administrators change the default AP group for new APs to AM mode and create a new AP group with the specific SSIDs and related configuration to be used for the organization. When the default is set to AM mode, anyone who plugs an unauthorized Dell AP into the network simply adds to the monitoring capacity and does not create a potential security vulnerability.

CAUTION: The default SSID profile should not be used in a Dell deployment. Network administrators are encouraged to make the default profile an AM profile to help protect their network from "gray market" APs that users may attempt to connect to the WLAN.

To change the default AP group for new APs to an AM profile, change the default 802.11a and 802.11g radio profile of the default AP group to a radio profile that has the mode set to am-mode. The example network uses the airmonitor radio profile for this purpose.

In Dell PowerConnect W-Series ArubaOS 6.1, the default SSID has been removed from the default AP group. So an AP that is automatically placed in the default AP group by a Dell controller running W-Series ArubaOS 6.1 will not broadcast any SSID.

CLI Configuration (Pre Dell PowerConnect W-Series 6.1 ArubaOS)

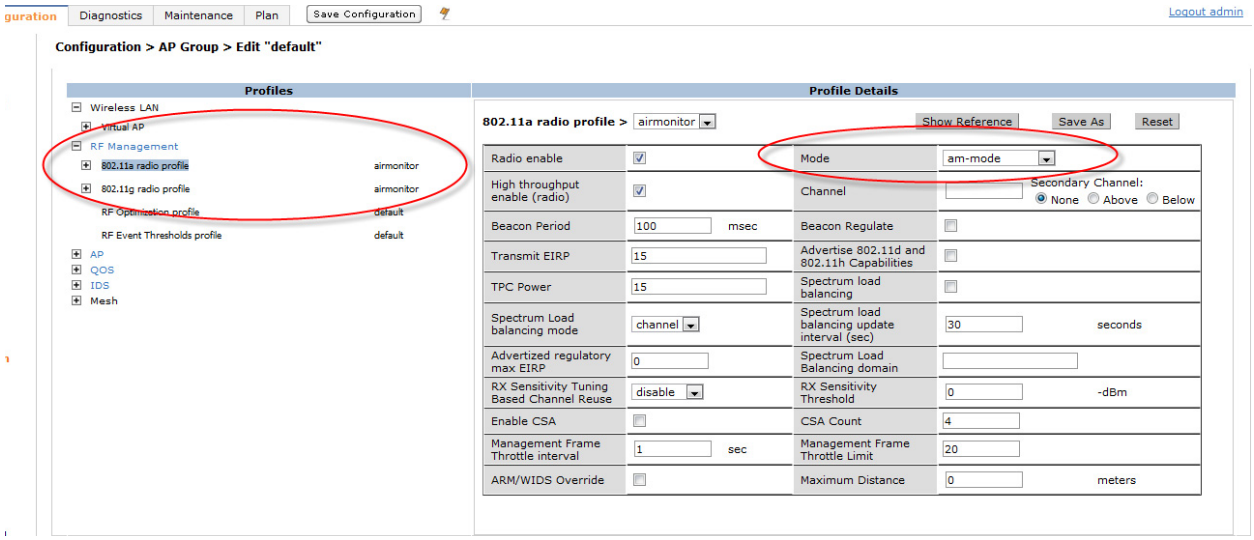
MC1-3600

```
!
ap-group "default"
  virtual-ap "default"
  dot11a-radio-profile "airmonitor"
  dot11g-radio-profile "airmonitor"
!
```

WebUI Screenshot (Pre 6.1 ArubaOS)

MC1-3600

Figure 85 *Altering the default AP group*



Chapter 18: Wireless Intrusion Prevention (IDS Profiles) of RFProtect

In any wireless network, it is important to protect the network against wireless attacks. Wireless security must be used in many regulated industries such as:

- healthcare
- federal
- payment card industry

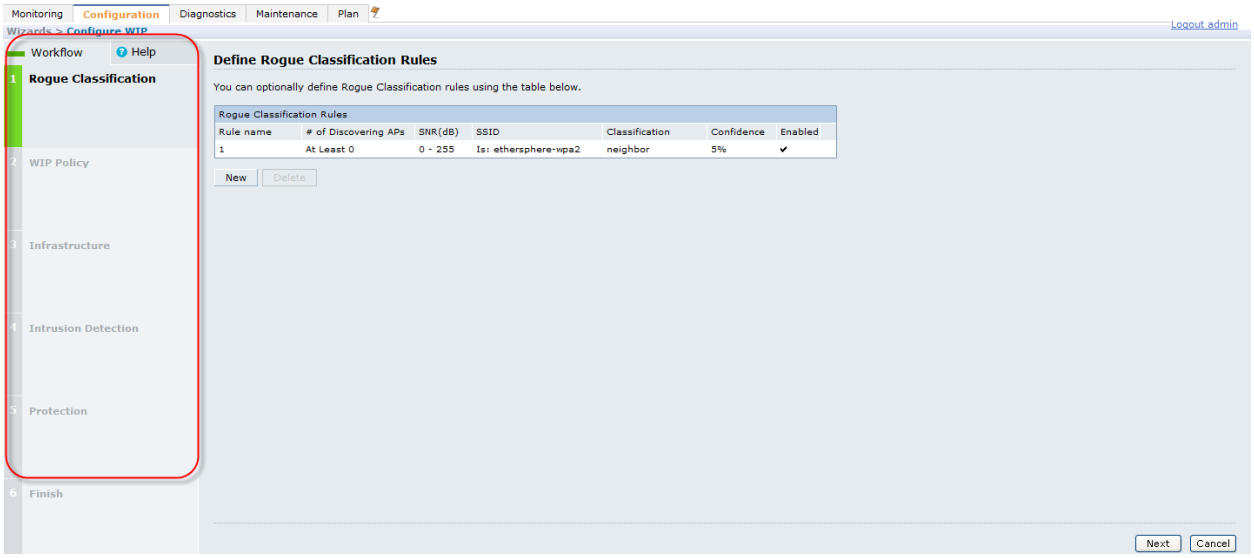
The Dell PowerConnect W-Series ArubaOS wireless intrusion prevention (WIP) feature of the RFProtect software module provides a wide range of intrusion detection and intrusion prevention capabilities.

The RFProtect feature set of Dell PowerConnect W-Series ArubaOS 6.1 also includes a patented containment called tarpitting. For more details on tarpitting and other RFProtect features, see the *Dell PowerConnect W-Series 802.11n Networks Validated Reference Design.* The intrusion detection system (IDS) profiles define all the possible WIP settings. Wireless security can be a complex topic with many different options, and it can be difficult to manage the wide range of IDS profiles available. To make things easier for users, a set of powerful wizards are available that provide reasonable default values and help a user step through the available configuration options. You select a default template that provides an acceptable level of security for the network or a customized set of options. The wizard simplifies the selection of security options and helps to eliminate errors in the configuration. Dell recommends the use of the WIP wizard for WIP configuration.

The WIP wizard provides the options to enable, define, or change the following items:

- rule-based rogue classification
- WIP policy creation and assignment to AP groups
- detection options for infrastructure attacks
- detection options for WLAN clients attacks
- protection options for infrastructure attacks
- protection options for WLAN clients attacks

Figure 86 *Configuration options in the WIP wizard*



In rule-based classification, an AP is classified as a suspected rogue or as a neighbor, depending on the user-defined rules. The AP classification rules can be specified by the SSID of the AP, signal-to-noise ratio (SNR) of the AP, and/or the number of APs that can see that AP. The rule-based classification is very useful for differentiating neighbors and rogues.

The detection setting on the wizard for the infrastructure and the client can be turned off or set to a predefined high, medium, or low level. The wizard also allows custom settings. The high detection setting enables all the protection mechanisms applicable. The medium setting enables some important protection mechanisms, and the low setting enables only the most critical protection mechanisms.

The protection settings for infrastructure have the same option as the detection settings, but the protection settings for clients can be set only to low or high.

Security requirements are specific to each organization. Dell recommends that you turn on all the critical attacks that are defined in the lowest setting and then customize it to meet the needs of your network. If you turn on all the WIP features, too many alarms can interfere with the performance of your network and your neighboring WLANs. Consult an RF security expert and the Legal department to determine the security needs and legal implications, if any.

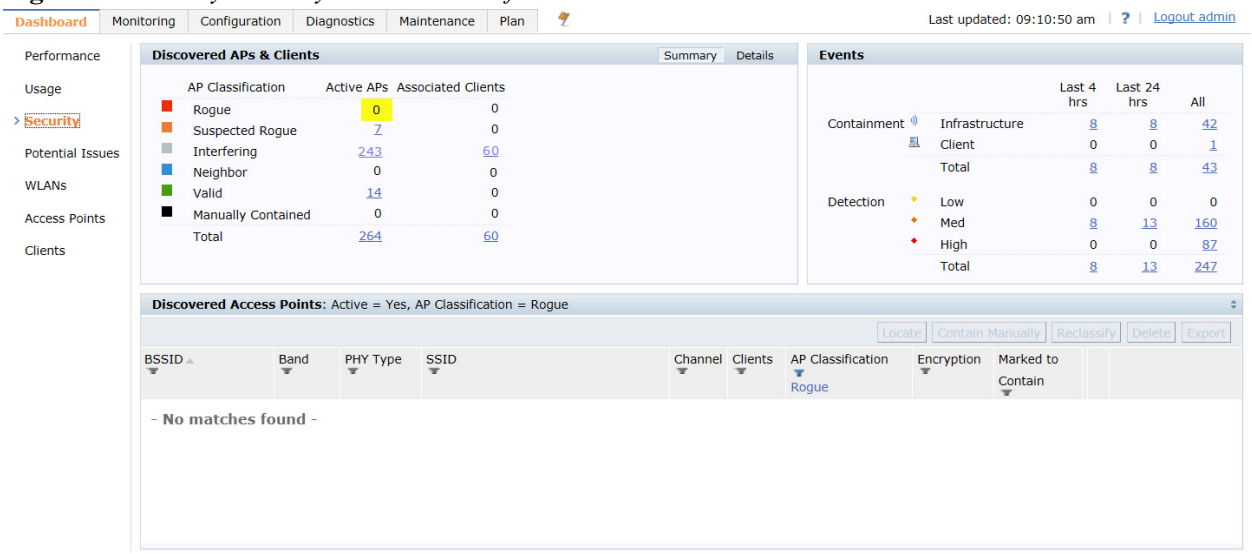
The example network uses a policy named Corp-WIPS with the low setting for all the detection and protecting options. Use the default containment settings for most deployments. The default setting for containment has wired containment turned on and uses the tarpit-non-valid-station option for wireless containment. For details about the configuration of WIPS, see the *Dell PowerConnect W-Series ArubaOS 6.1 User Guide* available at support.dell.com/manuals.

△ **CAUTION: Only rogues on legal channels are contained. TotalWatch detects and reports all the rogue APs, but action can be taken only against rogues that operate within the regulatory domain.**

Sample Screenshots

- Security summary result in the absence of a rule for rule-based classification

Figure 87 *Security summary in the absence of a rule*



- Security summary result on the example network after defining a rule that classifies the ethersphere-wpa2 network as a neighbor

Figure 88 *Defining a rule to identify neighbors*

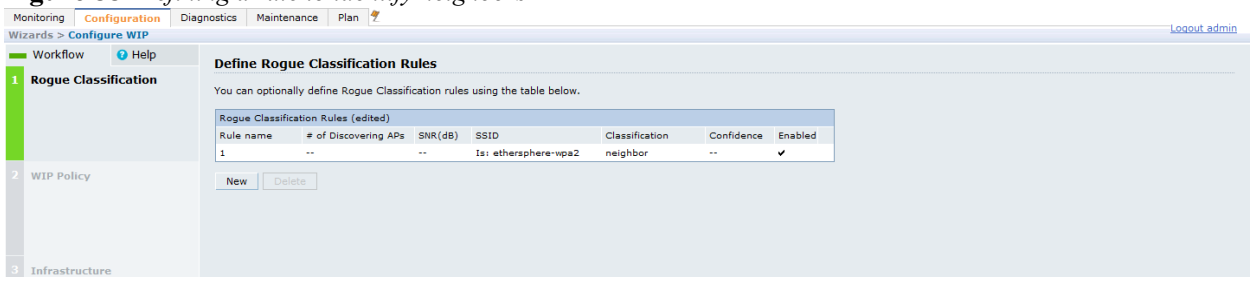
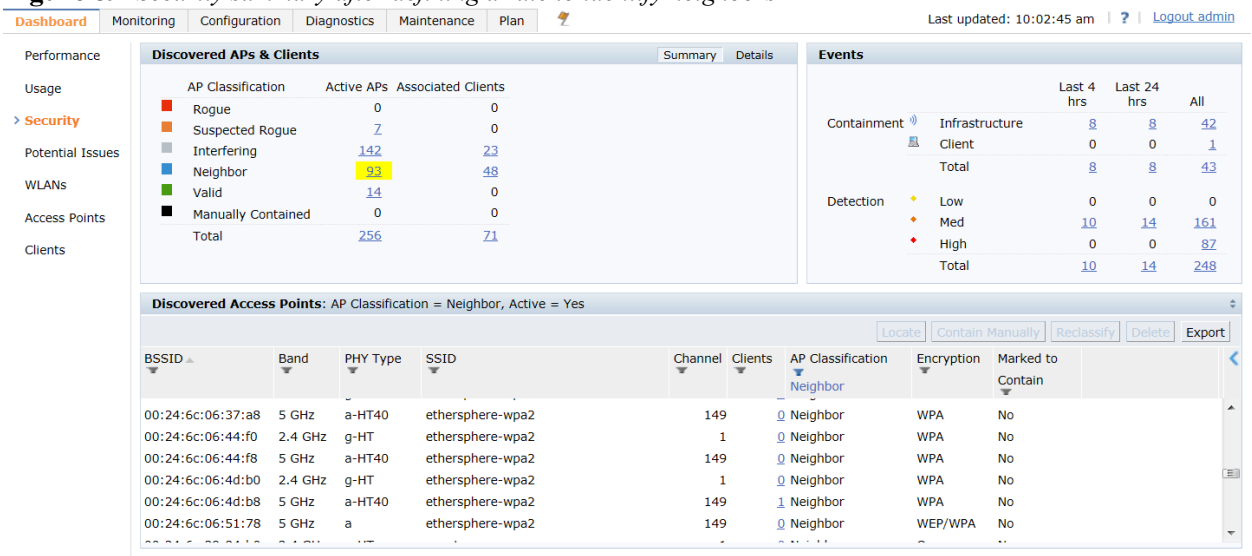
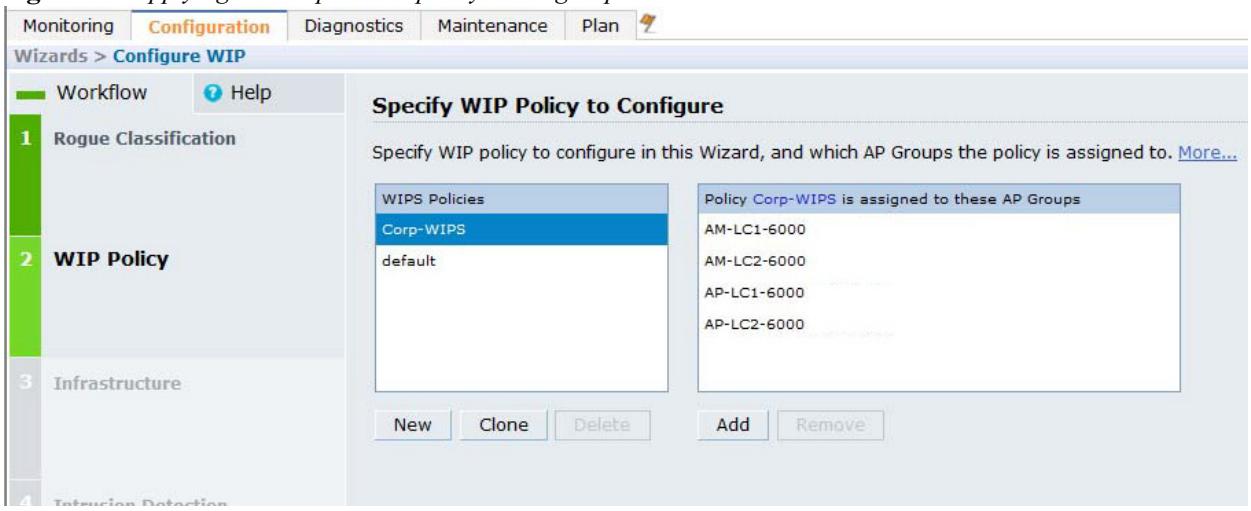


Figure 89 *Security summary after defining a rule to identify neighbors*



- Applying the Corp-WIPS policy to the AP groups in the example network

Figure 90 *Applying the Corps-WIPS policy to AP groups*



- In the IDS wizard, the valid SSIDs list is automatically populated with all unique SSIDs configured in SSID profiles and any unique cluster names configured in AP mesh cluster profiles. Only the SSIDs that are not present on the controller should be added.

Figure 91 *Adding a valid SSID for the Detect Adhoc Networks feature*

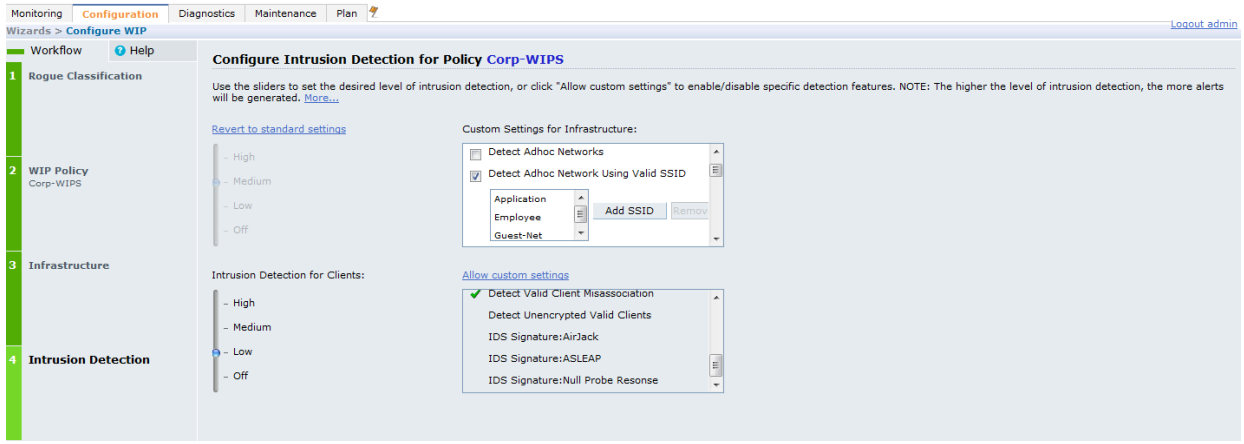
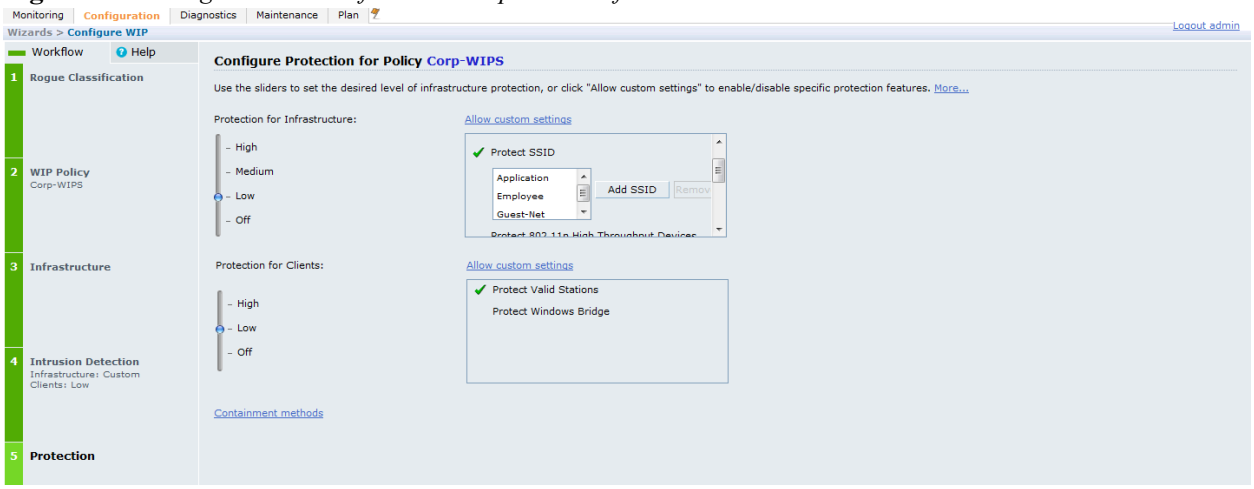


Figure 92 *Adding a valid SSID for the SSID protection feature*



Chapter 19: Spectrum Analysis

Wi-Fi operates in the unlicensed but regulated RF bands of the 2.4 and 5 GHz spectrums. These bands are unlicensed, so anyone can use them as long as they follow the rules and regulations of the unlicensed spectrum. So, the possible sources of interference are large. In most cases, the presence of an interfering device is the main reason for WLAN performance degradation. Dell PowerConnect W-Series ArubaOS 6.1 offers spectrum analysis. Spectrum analysis is an RF troubleshooting tool that identifies, classifies, and finds sources of RF interference and provides a true visualization of the RF environment.

Spectrum analysis requires that you deploy APs as spectrum monitors (SMs). When in SM mode, an AP does not serve clients or take part in rogue AP containment. Instead the AP samples the RF band and provides data to the mobility controller. On the WebUI of the mobility controller, a spectrum dashboard displays the data that is collected by the SM. The data is displayed as a series of graphs on a user-customizable dashboard. This data is streamed to the client, and can be recorded for later analysis. For more details about the spectrum dashboard and the basics of spectrum analysis, see the *Dell PowerConnect W-Series 802.11n Networks Validated Reference Design.*

Figure 93 *An active SM detects interference from non-Wi-Fi sources*

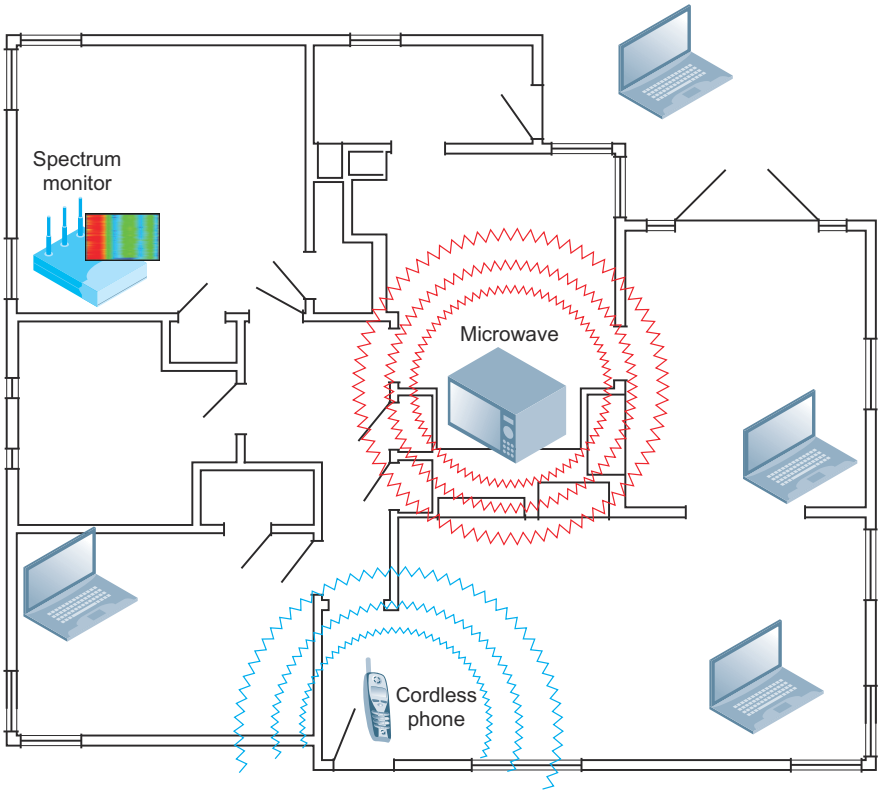
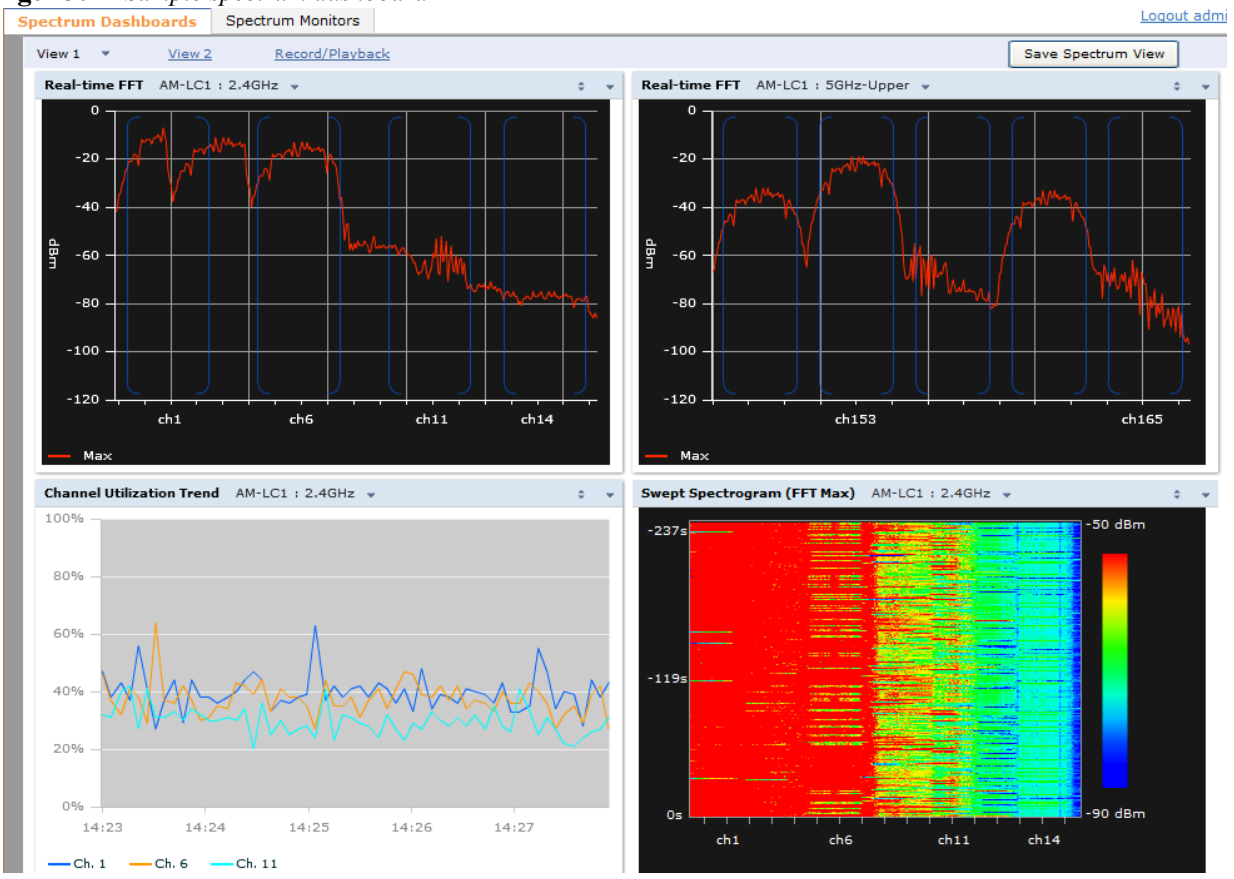


Figure 94 *Sample spectrum dashboard*



Most organizations use spectrum analysis only during troubleshooting, but some need spectrum analysis capabilities on a permanent basis. If you need spectrum analysis to be enabled always, deploy APs as dedicated SMs all across the network. In these situations, use a separate AP group with the 802.11a and 802.11g radio modes set to spectrum-mode.

When you use spectrum analysis on temporary basis to troubleshoot client problems, you can convert an AP or AM temporarily to an SM. You need not create a separate AP group or change the radio modes. Use the spectrum local override profile to convert an AP or AM into an SM. The AP functions as an SM until that AP is removed from the spectrum local override profile. When it is removed from that profile, the AP reverts back to its original configuration. The SM profile also requires that you specify the band to be scanned. A dual-radio AP can scan the 2.4 GHz band and one of the 5 GHz bands at the same time. However, a single-radio, dual-band AP can monitor only one band at a time.

When you change an AP radio to an SM using the local override profile, make this change through the WebUI or CLI of the controller that terminates the AP. In campus deployments, this controller is usually a local controller and not a master controller.

The example network uses spectrum analysis for temporary troubleshooting, so it uses the spectrum local override profile. In the example network, AM-LC1 is changed to an SM when the AM-LC1 name is added to the spectrum local override profile on the LC1-600 controller. Then the band to be analyzed is specified. One radio on AM-LC1 is set to monitor the 2.4 GHz band, and the other is set to monitor the 5 GHz upper band. When you remove AM-LC1 from the profile, it becomes an AM again.

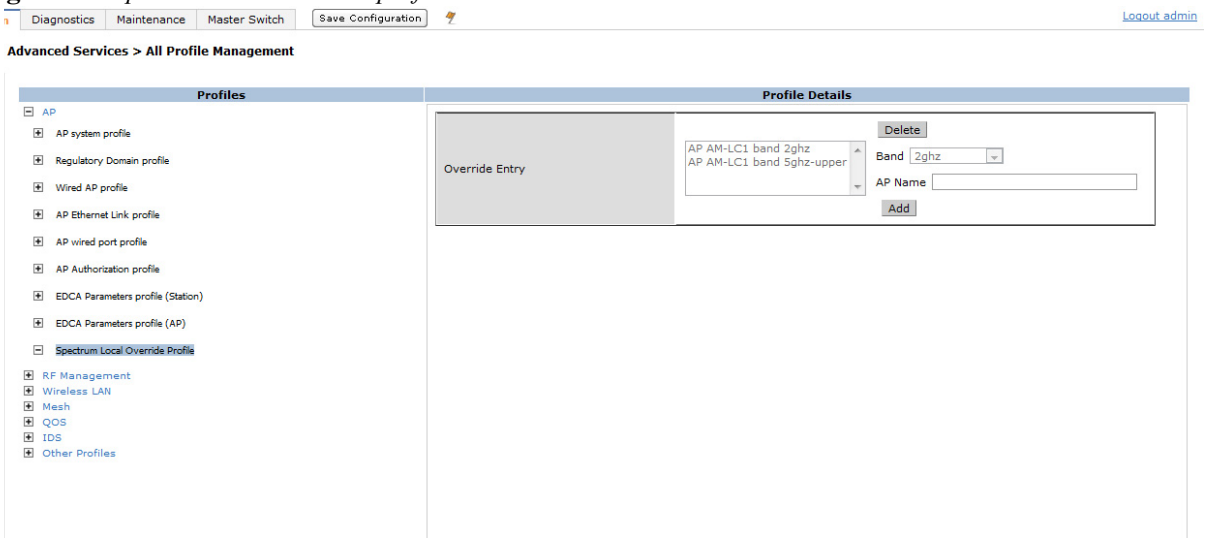
CLI Configuration

```
!
ap spectrum local-override
override ap-name AM-LC1 spectrum-band 2ghz
override ap-name AM-LC1 spectrum-band 5ghz-upper
```

!

WebUI Screenshot

Figure 95 *Spectrum local override profile*

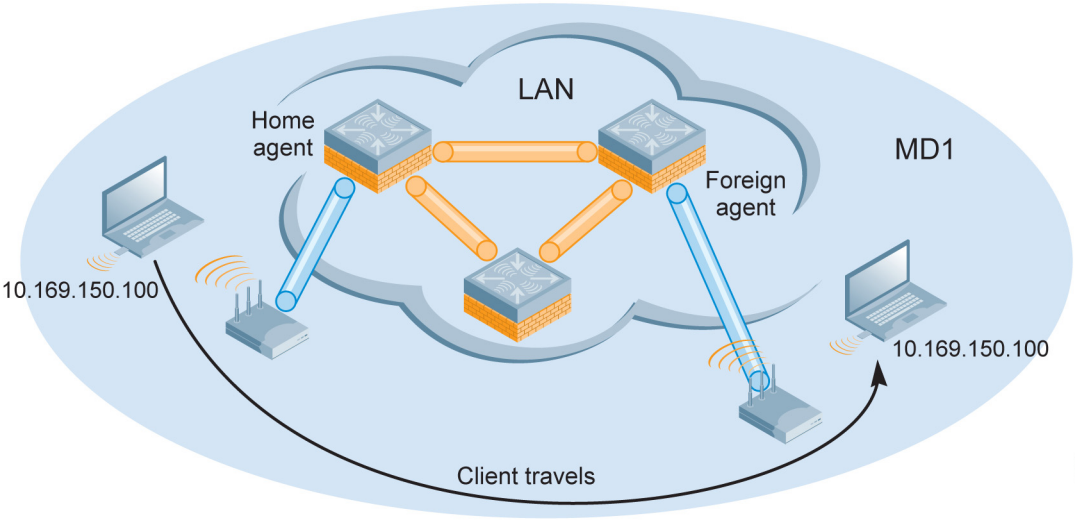


Dell PowerConnect W-Series ArubaOS uses different client mobility services to provide seamless wireless connectivity as users move through the network. These services allow users to keep the same IP addresses and connectivity as long as their station is active and moving through a contiguous coverage area. Mobility in a wireless network is provided either across a Layer 2 domain (VLAN mobility) or across a Layer 3 domain (IP mobility). VLAN mobility does not scale well in a large campus deployment, because it works only across controllers and APs that share the same VLANs (broadcast domains) among them. Dell recommends Layer 3 mobility any time more than two active mobility controllers are present in the network. Though this configuration creates more overhead for the administrator initially, it leads to a cleaner network design where VLANs exist in fewer places and are less likely to be overloaded. Dell PowerConnect W-Series ArubaOS provides Layer 3 roaming (also known as IP mobility), with the implementation of mobile IP addressing that is specified in RFC 3344.

Configuring the Mobility Domain

In the example network, employee and application WLANs that are broadcast by AP-LC1 that terminate on VRRP-7 VIP have a different VLAN pool than the AP-LC2 that terminates on VRRP-8 VIP. In this case, when a user that is connected to the employee SSID moves from AP-LC1 to AP-LC2, he essentially has moved across a Layer 3 domain. The user has moved from one of the VLANs in pool-7 (VLANs 150-154) to one of the VLANs in pool-8 (VLANs 155-159). This move is considered to be a Layer 3 roaming event.

Figure 96 *Layer 3 Mobility*



Before you configure a mobility domain, you must determine the user VLAN(s) for which mobility is required. To allow employees to be able to roam from one subnetwork to another, all controllers that support the VLANs into which employee users can be placed should be part of the same mobility domain.

A controller can be part of multiple mobility domains, but this situation is not recommended. In a master/local operation, the mobility domain is configured on the master controller, which pushes the information to all local controllers that are managed by it. On the individual controller, you must specify an active domain to which that controller belongs. Though the mobility domain is configured on a master controller, the master controller does not have to be a member of the domain.

The mobility domain uses the home agent table (HAT) to locate the home agent for each client. The HAT maps each user VLAN ID to a home agent address. In campus deployments, use the VRRP IP as the home agent address for the

user VLAN that is included in the mobility domain. The IP address the controller on which the APs terminate can be used as the home agent address if VRRP is not implemented.

NOTE: Do not configure both a controller IP and a VRRP IP as home agent address, otherwise multiple home agent discoveries will be sent to the controller.

In the example network, the clients are managed only by the local controllers. Only LC1-6000 and LC2-6000 are members of the mobility domain. Here a mobility domain called Corp is created, which allows employee and application clients to roam across Layer 3 boundaries. VRRP-7 IP is used as the home agent address for VLANs 150-154, and VRRP-8 IP is used as the home agent address for VLANs 155-159.

NOTE: Mobility is disabled by default.

The configuration of Layer 3 mobility has two steps:

1. Create a mobility domain and the corresponding HAT on the master controller. In the example network a mobility domain named Corp with corresponding HAT entries is created on MC1-3600 controller.
2. Make the mobility domain created in step 1 as the active domain on the controllers that are a part it. In the example network, the Corp mobility domain is made the active domain in LC1-6000 and LC2-6000 controllers.

NOTE: Mobility between local controllers will work without mobility being enabled in the master controller as long as none of the HAT entries point to the master controller as the home agent.

Table 38 lists the HAT parameters of the Corp mobility domain used in the example network.

Table 38 *HAT Parameters*

Subnet	Netmask	VLAN ID	Home Agent	Description
10.169.150.0	255.255.255.0	150	10.169.145.7	Corp
10.169.151.0	255.255.255.0	151	10.169.145.7	Corp
10.169.152.0	255.255.255.0	152	10.169.145.7	Corp
10.169.153.0	255.255.255.0	153	10.169.145.7	Corp
10.169.154.0	255.255.255.0	154	10.169.145.7	Corp
10.169.155.0	255.255.255.0	155	10.169.145.8	Corp
10.169.156.0	255.255.255.0	156	10.169.145.8	Corp
10.169.157.0	255.255.255.0	157	10.169.145.8	Corp

Table 38 *HAT Parameters (Continued)*

Subnet	Netmask	VLAN ID	Home Agent	Description
10.169.158.0	255.255.255.0	158	10.169.145.8	Corp
10.169.159.0	255.255.255.0	159	10.169.145.8	Corp

CLI Configuration

MC1-3600

```
!
ip mobile domain Corp
  description "for Corp users"
  hat 10.169.150.0 255.255.255.0 150 10.169.145.7 description "Corp"
  hat 10.169.151.0 255.255.255.0 151 10.169.145.7 description "Corp"
  hat 10.169.152.0 255.255.255.0 152 10.169.145.7 description "Corp"
  hat 10.169.153.0 255.255.255.0 153 10.169.145.7 description "Corp"
  hat 10.169.154.0 255.255.255.0 154 10.169.145.7 description "Corp"
  hat 10.169.155.0 255.255.255.0 155 10.169.145.8 description "Corp"
  hat 10.169.156.0 255.255.255.0 156 10.169.145.8 description "Corp"
  hat 10.169.157.0 255.255.255.0 157 10.169.145.8 description "Corp"
  hat 10.169.158.0 255.255.255.0 158 10.169.145.8 description "Corp"
  hat 10.169.159.0 255.255.255.0 159 10.169.145.8 description "Corp"
!
```

NOTE: Mobility is not enabled on the MC1-3600 controller, so while you configure the mobility domain on the master controller, ignore the following warning:
*** WARNING ***: Mobility service is disabled (router mobile)

LC1-6000

```
!
router mobile
ip mobile active-domain Corp
!
```

LC2-6000

```
!
router mobile
ip mobile active-domain Corp
!
```

WebUI Screenshot

Figure 97 *Mobility domain for MC1-3600*

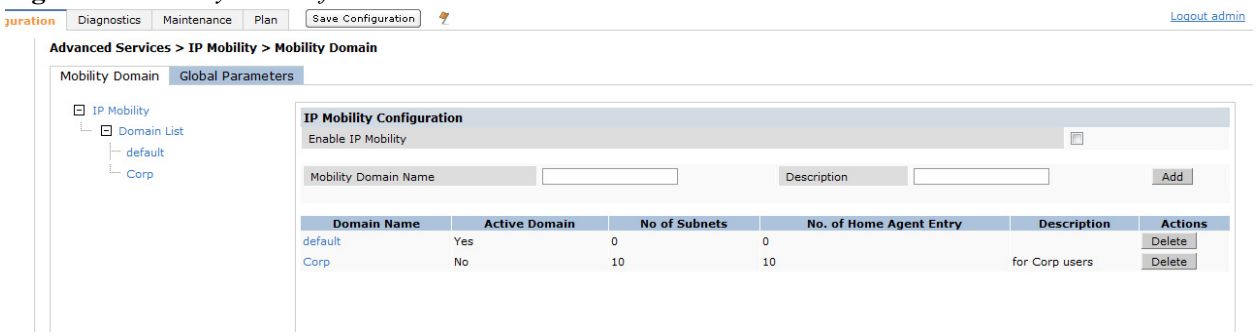


Figure 98 *HAT on MC1-3600*

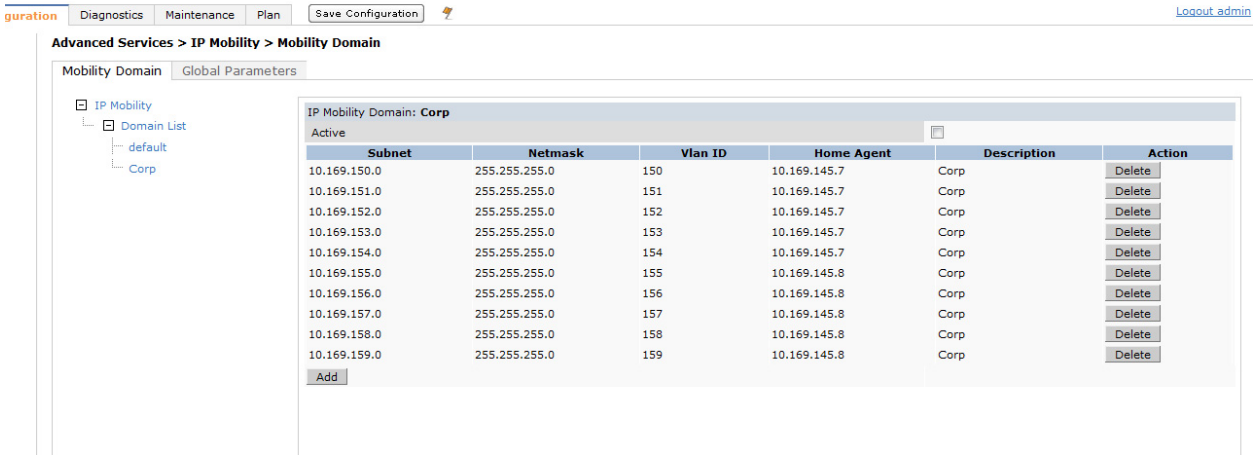


Figure 99 *Mobility domain LC1-6000*

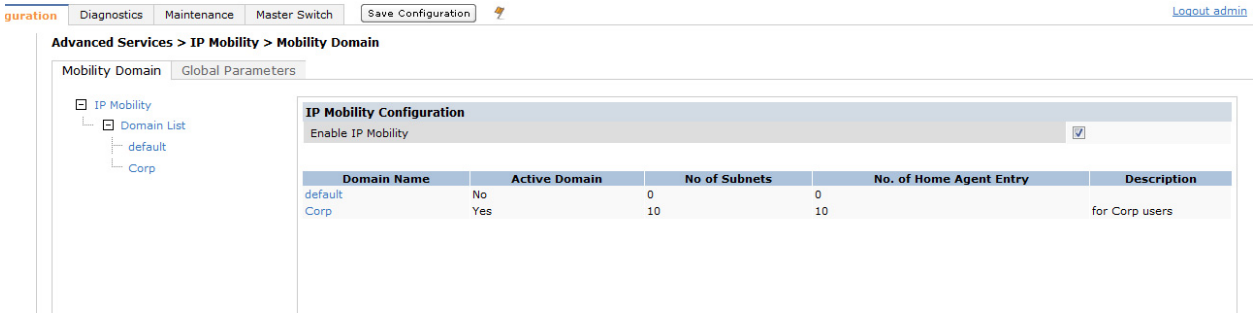
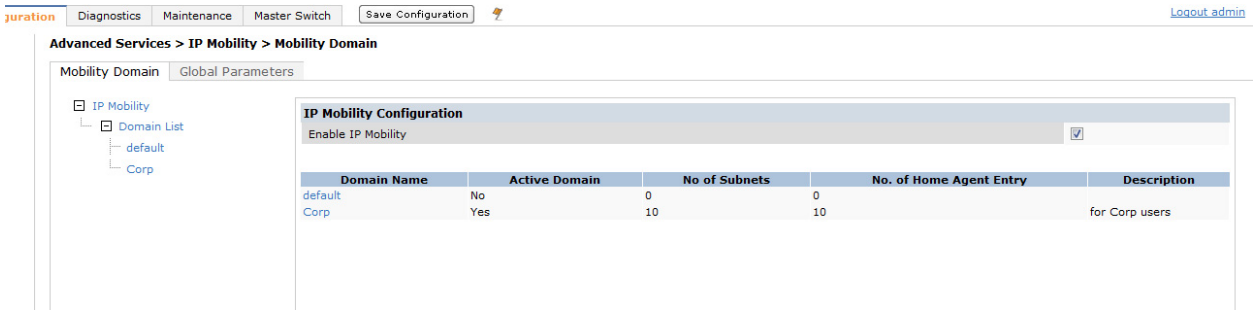


Figure 100 *Mobility domain LC2-6000*



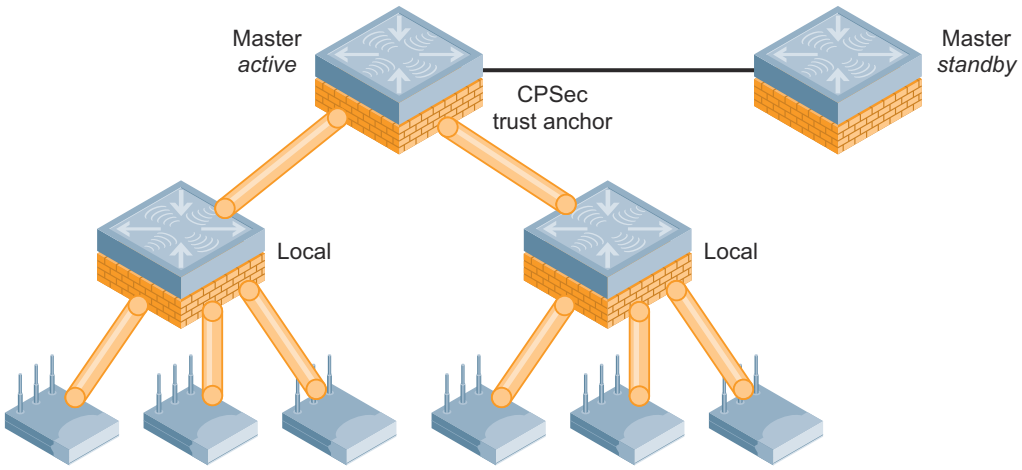
Chapter 21: Control Plane Security

Dell PowerConnect W-Series ArubaOS 6.1 offers control plane security (CPsec). CPsec is a certificate-based mechanism that protects control plane traffic using IPsec, and optionally authorizes APs to the Dell WLAN. In ArubaOS 6.1, CPsec is enabled by default for new deployments. Controllers that use CPsec certify only the APs that are identified as valid APs. APs can be defined as valid either by manually adding the APs to the campus AP whitelist or by auto provisioning. Auto provisioning is easy to deploy, and though manual entry is cumbersome, it is more secure. Auto provisioning certifies that all APs that are connected to the network are valid. However, this increases the chance that a rogue or unwanted AP may also be certified. Dell recommends that you use auto provisioning only if you are sure that all the APs on the network are valid APs.

NOTE: Auto provisioning should be turned off after all the APs have been certified and have connected to the network using a secure channel. Turning off auto provisioning prevents the controller from issuing certificates to any rogue APs that may connect to network at a later time.

In a campus deployment with a master and its backup, the master controller generates a self-signed certificate and distributes it to the local controllers and the valid APs that are connected to the network. The certificate and keys are also passed to the backup master during periodic database synchronization.

Figure 101 *CPsec master/local cluster*



Each master and local controller in the network that is a part of a CPsec chain has a campus AP whitelist that includes all the valid APs in the network, regardless of whether that AP is connected to it or not. The campus AP whitelist can be updated on any controller in the network. The changes in the whitelist on any controller are pushed to all other controllers in the network.

NOTE: If a new controller is added to an existing deployment, make sure that the campus AP whitelist on the new controller is empty. This step is essential because any invalid AP information on the campus AP whitelist of the new controller is updated across all the controllers in the network.

If a trust anchor fails in a CPsec-enabled network that has no master controller redundancy, you must address it immediately. If the trust anchor fails in a single master deployment, no more local controllers can be added to the network. However, if the failed trust anchor has to be replaced with a new controller, then all the controllers and APs should be recertified. Recertification requires that you reboot the controllers and APs, which disrupts the network.

Deploy a backup master controller to solve this issue. The database synchronization between the active and standby master ensures that keys and certificates are synced on the standby controller. Dell strongly recommends that you deploy a backup controller for the CPsec trust anchor. Make sure that a database synchronization operation has occurred from primary master to backup at least once after the whole network is up and running. The synchronization ensures that all the certificates, keys, and whitelist entries that are required for CPsec are synced to the backup controller.

NOTE: If you add a backup controller for the trust anchor in a CPsec environment, the backup controller must be added as the lower priority controller. If you add it as the higher priority controller, the CPsec keys and certificate of the current master may be lost.

The example network has CPsec enabled and uses auto provisioning to validate the APs. Use auto provisioning only if you are confident that all the APs connected to the network are valid. If you are not sure, add the AP information manually. With auto provisioning, you can specify an IP range to which it will apply. For more information about CPsec, see the *PowerConnect W-Series Mobility Controllers VRD*.

CLI Configuration

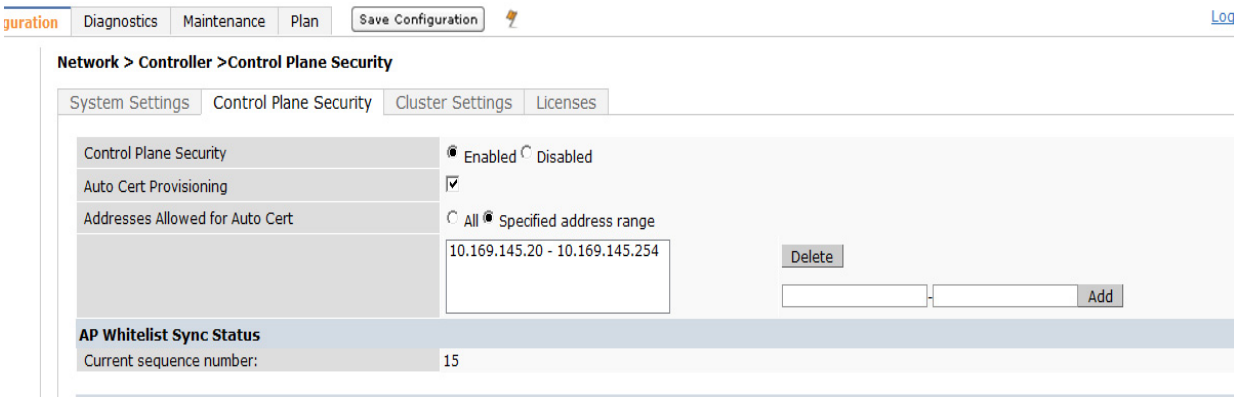
MC1-3600

```
!
control-plane-security
   auto-cert-prov
   no auto-cert-allow-all
   auto-cert-allowed-addrs 10.169.145.20 10.169.145.254
!
```

WebUI Screenshot

MC1-3600

Figure 102 *CPsec in the example network*



The AP can use DHCP for IP addressing and can automatically discover the Dell PowerConnect W-Series controller through a number of methods. This functionality makes it easy to add an AP to any existing employee port and VLAN.

If the AP and Dell controller share the same Layer 2 VLAN, then nothing else must be done. The AP automatically discovers the controller by using the Dell PowerConnect W-Series Aruba Discovery Protocol (ADP). If the AP and controller are separated by a Layer 3 network, then two other methods are available for controller discovery:

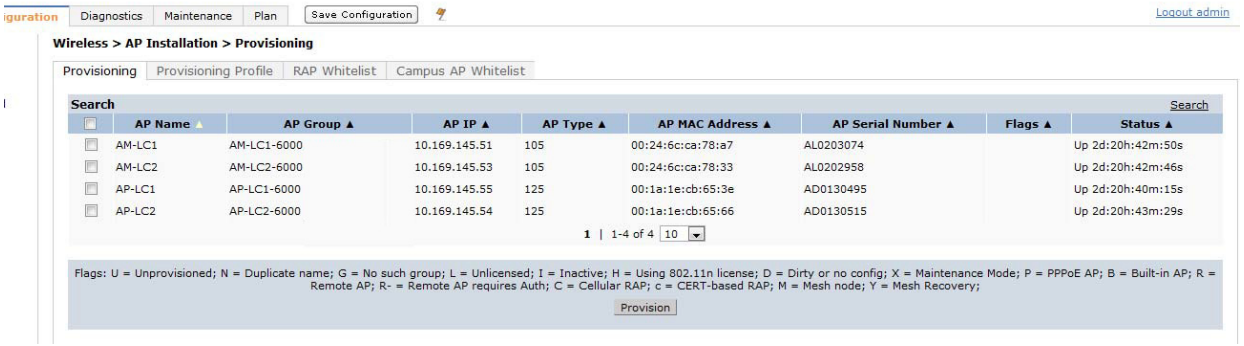
- An entry can be entered into the DNS of the organization for aruba-master with the IP address of the Dell controller.
- A DHCP option 43 value can be configured with the address of the Dell controller. For details about configuration of DHCP 43, see the *Dell PowerConnect W-Series ArubaOS 6.1 User Guide* available at support.dell.com/manuals.

NOTE: Dell recommends that you use a DNS server to provide APs with the IP address of the master controller. This approach involves minimal changes to the network and provides the greatest flexibility in the placement of APs.

All the APs that are discovered are available on the console of the master controller. Name the APs and assign them to the appropriate AP groups. The example network uses the DNS method.

Sample Screenshot

Figure 103 *Sample AP provisioning*



Chapter 23: Logging

Almost all network deployments use syslog servers. A syslog server is the central repository for all the event notification messages that various network devices generate. This information is useful for troubleshooting network problems and mitigating security threats. The Dell PowerConnect W-Series controller can use any of the Local Facility (0-7) to send the syslog messages. The logging level determines how often and how many notifications are sent to the syslog server. Logging all the notification messages can overwhelm the logs and may make debugging difficult. Logging all the messages also increases the traffic on the wired network. Consider these factors before you decide on the logging level. Configure syslog settings on all the controllers from which you need logs.

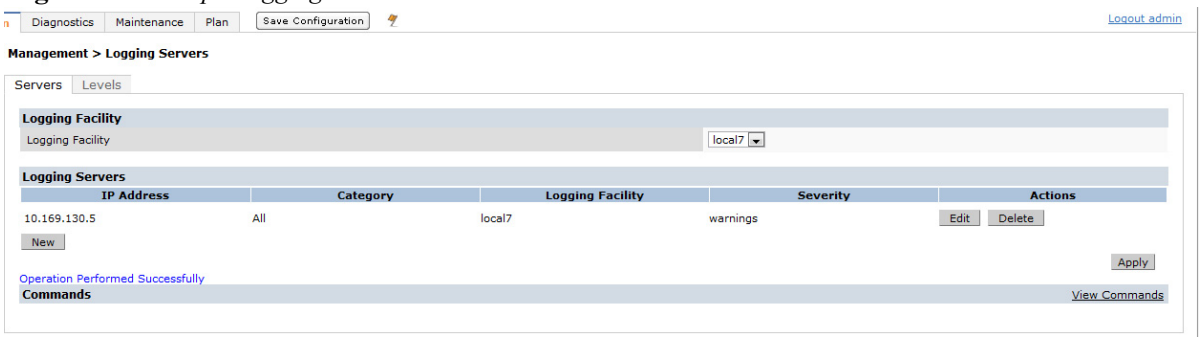
The example network uses the default logging level of warnings. The warnings level forwards all warning notifications to the syslog server.

CLI Configuration

```
!
logging level warnings network subcat all
logging level warnings network subcat dhcp
logging level warnings network subcat mobility
logging level warnings network subcat packet-dump
logging level warnings security subcat aaa
logging level warnings security subcat all
logging level warnings security subcat cpsec
logging level warnings security subcat db
logging level warnings security subcat dot1x
logging level warnings security subcat firewall
logging level warnings security subcat ids
logging level warnings security subcat ids-ap
logging level warnings security subcat ike
logging level warnings security subcat kerberos
logging level warnings security subcat mobility
logging level warnings security subcat ntlm
logging level warnings security subcat packet-trace
logging level warnings security subcat vpn
logging level warnings security subcat webserver
logging level warnings system subcat all
logging level warnings system subcat ap
logging level warnings system subcat configuration
logging level warnings system subcat messages
logging level warnings system subcat snmp
logging level warnings system subcat webserver
logging level warnings user subcat all
logging level warnings user subcat captive-portal
logging level warnings user subcat dot1x
logging level warnings user subcat radius
logging level warnings user subcat voice
logging level warnings user subcat vpn
logging level warnings wireless subcat all
logging facility local7
logging 10.169.130.5 severity warnings
```

WebUI Screenshot

Figure 104 *Sample logging*



As the network grows beyond a single master/local cluster, it becomes more complex to configure and troubleshoot. This complexity is increased further if more than a single cluster exists on the same campus, because users can easily roam between clusters. To simplify the job of the network administrator, use the AirWave system any time more than one master/local Dell PowerConnect W-Series controller cluster exists in the network. The AirWave system provides a consolidated view of all components and users on the network in a single, flexible console. In addition to the functionality already present in the Dell controllers, AirWave adds network-wide configuration, advanced reporting, and trending features. These additional features allow network administrators to interface with a single tool to plan, configure, and troubleshoot the network.

AirWave provides centralized configuration management, and allows network administrators to track client devices, identify rogue devices, plan new deployments, and visualize RF coverage patterns with an intuitive and seamless user interface.

AirWave monitors Dell PowerConnect W-Series devices using SNMP polling. The SNMP agent of the Dell PowerConnect W-Series controllers must be set up to respond to these SNMP polls and send SNMP traps to AirWave. AirWave also requires Telnet or SSH credentials and the enable password to acquire license and serial information from controllers. Configure the SNMP settings on all the controllers that must be monitored by AirWave.

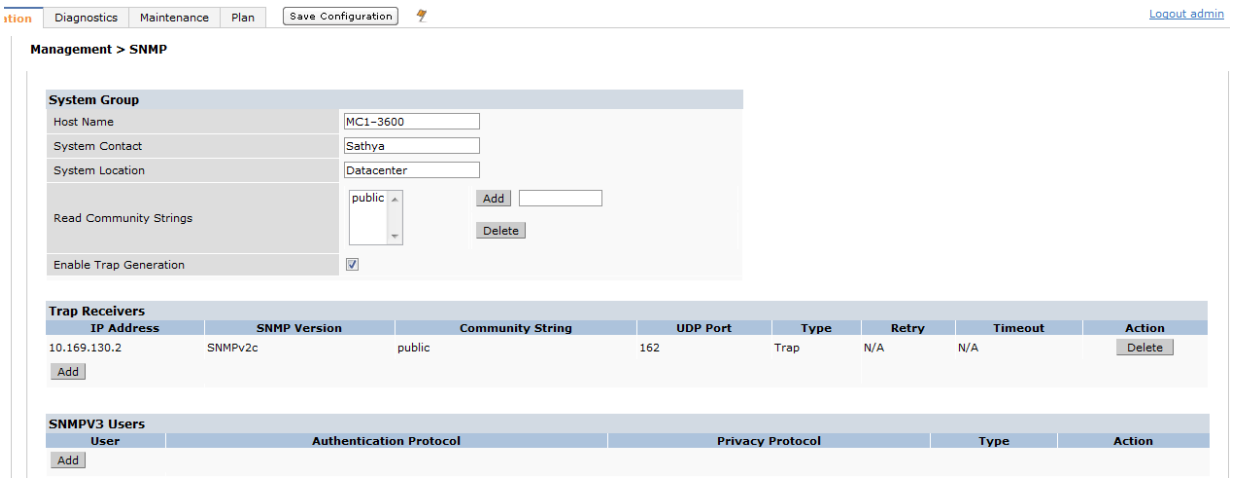
NOTE: The community string on the Dell controllers must match that on AirWave.

CLI Configuration

```
!
snmp-server community public
snmp-server enable trap
snmp-server host 10.169.130.2 version 2c public udp-port 162
!
```

WebUI Screenshot

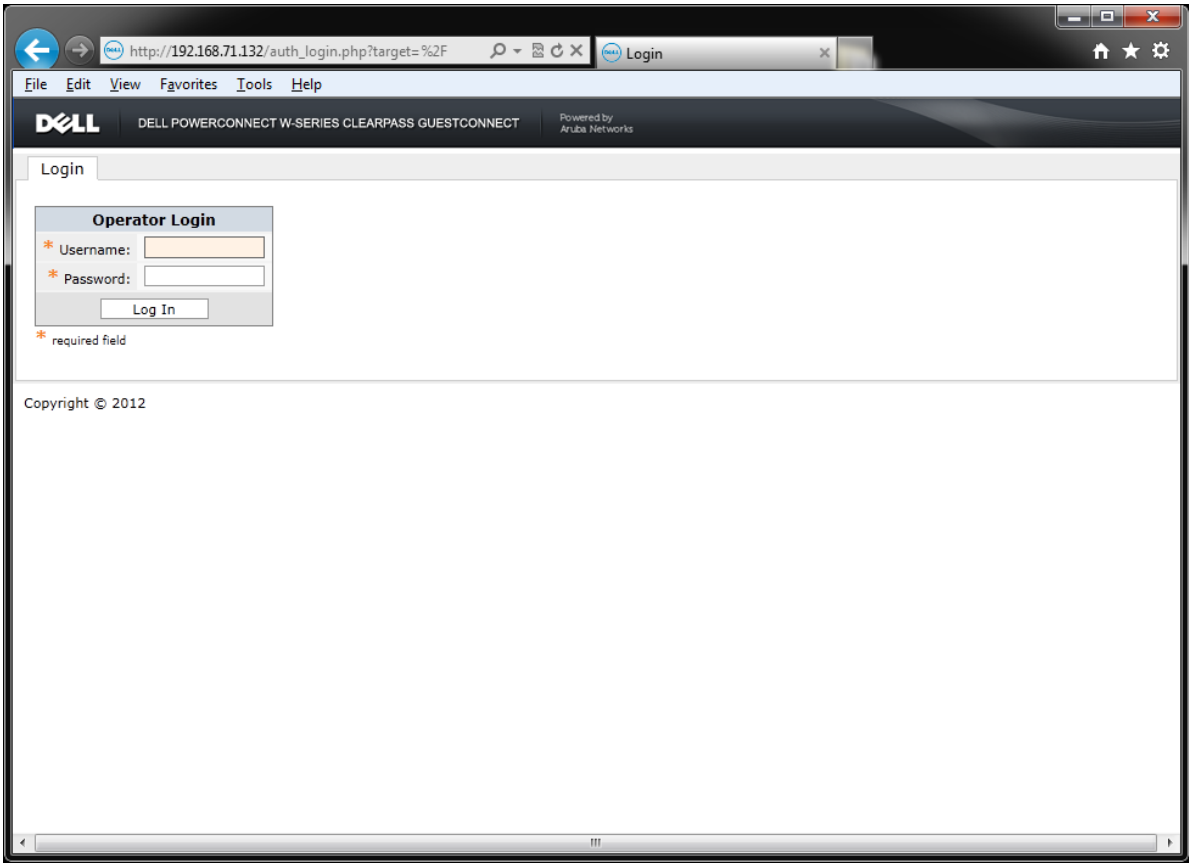
Figure 105 *Sample SNMP configuration*



Chapter 25: ClearPass GuestConnect

With visitors increasingly requiring online access to perform their work, visitor management has become a standard requirement for most campuses. On large campuses with hundreds of visitor each day, managing guess accounts is an unnecessary overhead for IT. To reduce the complexity and operational cost of visitor management, use the ClearPass GuestConnect solution. ClearPass GuestConnect is a unified visitor management solution with a fully functional RADIUS server and external captive portal support. The ClearPass GuestConnect solution provides the most intuitive and flexible way to manage external visitors to a Dell wireless network. ClearPass GuestConnect directly links the guest accounts to security policies configured on the Dell controller. ClearPass GuestConnect ensures that network administrators control the underlying security policy related to guest network access, but nontechnical staff can easily and securely manage the day-to-day administration of guest accounts. If required, ClearPass GuestConnect can also be configured to provide self-registration for guests and employee mobile devices. ClearPass GuestConnect also offers fully customizable captive portal pages and powerful logging and reporting capabilities. For more information on the special features and deployment scenarios of ClearPass GuestConnect, see the ClearPass GuestConnect deployment guide. The PowerConnect W-Series manual website can be reached by going to support.dell.com/manuals and choosing any W-Series product.

Figure 106 *Default ClearPass GuestConnect login page (customizable)*



Appendix A: Link Aggregation

Link aggregation bonds multiple parallel links between two network interfaces to form a single link. Link aggregation is a simple and cost-effective way to increase bandwidth and reliability. The implementation of the Link Aggregation Control Protocol (LACP) is based on the standards specified in IEEE 802.3ad. The implementation of LACP automates the configuration, reconfiguration, and maintenance of aggregated links between devices. Two devices configured with LACP exchange LACPDUs to form a link aggregation group (LAG). The load is maintained and readjusted automatically if any link in the LAG fails or recovers.

Configuring LACP

The following examples show the configuration of LACP for a Dell PowerConnect W-Series controller.

Dell PowerConnect W-Series Controller

```
!
interface port-channel 1
    trusted
    trusted vlan 1-4094
    switchport mode trunk
!
interface gigabitethernet 0/10
    description "XG0/10"
    trusted
    trusted vlan 1-4094
    lacp group 1 mode active
!

interface gigabitethernet 0/11
    description "XG0/11"
    trusted
    trusted vlan 1-4094
    lacp group 1 mode active
!
```

NOTE: Make sure that the port channel is configured as trusted.

Useful LACP Troubleshooting Commands

- Using “counters” shows the LACP received (Rx) traffic, transmitting (Tx) traffic, and data units (DU) received and transmitted by the port.

```
(LC1-6000) # show lacp <group ID> counters

LACP Counter Table
------------------
```

```
Port     LACPDUTx  LACPDURx  MrkrTx  MrkrRx  MrkrRspTx  MrkrRspRx  ErrPktRx
----     --------  --------  ------  ------  ---------  ---------  --------
XG 0/10  187800    203257    0       0       0          0          0
XG 0/11  187799    203244    0       0       0          0          0
```

- Using “internal” shows the status of the ports in a LAG. (See the last column.)

```
 (LC1-6000) #show lacp  1 internal

Flags: S - Device is requesting slow LACPDUs
       F - Device is requesting fast LACPDUs
       A - Device is in Active mode P - Device is in Passive mode
LACP Internal Table
-------------------
Port     Flags  Pri  AdminKey  OperKey  State  Num  Status
----     -----  ---  --------  -------  -----  ---  ------
XG 0/10  SA     255  0x2       0x2      0x3d   0xb  up
XG 0/11  SA     255  0x2       0x2      0x3d   0xc  up
```

- Using “neighbor” shows the mode and LACP parameters of the neighbors.

```
(LC1-6000) #show lacp 1 neighbor

Flags: S - Device is requesting slow LACPDUs
       F - Device is requesting fast LACPDUs
       A - Device is in Active mode P - Device is in Passive mode
LACP Neighbor Table
-------------------
Port     Flags  Pri    OperKey  State  Num    Dev Id
----     -----  ---    -------  -----  ---    ------
XG 0/10  SA     32768  0x1      0x3d   0x11e  C8:4C:75:FB:E0:00
XG 0/11  SA     32768  0x1      0x3d   0x11f  C8:4C:75:FB:E0:00
```

Configuring LACP on the Distribution Switch

User Guides for Dell PowerConnect switches are available at **support.dell.com/manuals** and cover the necessary LACP commands and options to create a LAG to the Dell PowerConnect W-Series controller. For a non-Dell switch, consult the User Guide provided with the switch to locate the LACP commands for that device.